PRELIMINARY ASSESSMENT
FOR
AMERICAN FORK CANYON
UINTA NATIONAL FOREST, UTAH COUNTY, UTAH

Prepared for
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 8

Prepared by
WESTON SOLUTIONS, INC.
Region 8 Superfund Technical Assessment and Response Team

March 2018

Date Prepared	March 15, 2018
SEMS ID/SSID:	UTD988074951/08CW
TDD No.	0004/1610-01
Document Control No.	W0412.1A.01253
Contract No.	EP-S8-13-01
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LIST OF ACRONYMS

µg/L	micrograms per liter
ac-ft	acre-feet
amsl	above mean sea level
AD	adit drainage
AF	American Fork Canyon
APM	above Pacific mine
ASTDR	Agency for Toxic Substance and Disease Registry
ATV	all-terrain vehicle
AWQC	ambient water quality criteria
AWQMS	Ambient Water Quality Monitoring System
BCT	Bonneville Cutthroat Trout
bgs	below ground surface
BK	background
BMA	Bog mine adit
BTAG	Biological Technical Assistance Group
CCC	Criteria Continuous Concentration
CEO	Chief Executive Officer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
cfs	cubic feet per second
Cirrus	Cirrus Ecological Solutions LC
CMC	Criteria Maximum Concentration
CO	Compliance Order
COPC	Contaminants of Potential Concern
CUP	Conditional Use Permit
CWA	Clean Water Act
DAR	Division of Administrative Rules
DERR	Division of Environmental Response and Remediation
DO	dissolved oxygen
DOGM	Utah Division of Oil Gas and Mining
DS	downstream
DWQ	Division of Water Quality
DWR	Utah Division of Wildlife Resources
ECOS	Environmental Conservation Online System
EE/CA	Engineering Evaluation /Cost Analysis
EEP	Environmental Epidemiology Program
EMEG	Environmental Media Evaluation Guideline
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration

LIST OF ACRONYMS (Continued)

ft	feet
FSR	U.S. Forest Service Road
gpm	gallons per minute
GPS	Global Positioning System
HC	horizontal closed
HRS	Hazard Ranking System
IPaC	Information, Planning, and Conservation System
lbs/day	pounds per day
MB	Mineral Basin
MEG	Mary Ellen Gulch
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MH	Miller Hill
MHT	Miller Hill Tunnel
MLID	Monitoring Location Identification
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Units
NUCWCD	North Utah County Water Conservation District
OSC	On-Scene Coordinator
PA	Preliminary Assessment
PEC	probable effect concentration
PMA	Pacific mine adit
PPAFC	Protect and Preserve American Fork Canyon
ppm	parts per million
PRG	Preliminary Remediation Goal
REAC	Response Engineering and Analytical Contract
RME	Reasonable Maximum Exposure
RMEG	Reference Dose Media Evaluation Guidelines
RSL	Regional Screening Level
SAIC	Science Applications International Corporation
SAM	Site Assessment Manager
SCDM	Superfund Chemical Data Matrix
Snowbird	Snowbird Ski & Summer Resort
START	Superfund Technical Assessment and Response Team
TAL	Target Analyte List
TCRA	Time-Critical Removal Action
TDD	Technical Direction Document
TDL	target distance limit

LIST OF ACRONYMS (Continued)

TDS	total dissolved solids
TEC	Threshold Effect Concentrations
TMDL	total maximum daily load
TSS	total suspended solids
UAC	Utah Administrative Code
UCA	Utah Code Annotated
UDEQ	Utah Department of Environmental Quality
UDNR	Utah Department of Natural Resources
UNHP	Utah Natural Heritage Program
UOAR	Utah Office of Administrative Rules
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	United States Geological Survey
UT	Utah
WESTON	Weston Solutions, Inc.
WQS	Utah Standards of Quality for Waters of the State R317.2
WRCC	Western Regional Climate Center
XRF	X-ray fluorescence

1.0 INTRODUCTION

This Preliminary Assessment (PA) for the American Fork Canyon area (AF Canyon) in the Uinta National Forest, Utah County, Utah (UT) (Figures 1 and 2) has been prepared to partially satisfy the requirements of Technical Direction Document (TDD) No. 1610-01 issued to Weston Solutions, Inc. (WESTON) under the U.S. Environmental Protection Agency (EPA) Region 8 Superfund Technical Assessment and Response Team (START) Contract No. EP-S8-13-01.

This PA is being conducted at the American Fork Canyon/Uinta National site (Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] ID# UTD988074951) and surrounding vicinity to provide a comprehensive assessment of the area to determine whether mining related sources pose a threat to human health and the environment, and if further investigation under CERCLA is warranted. This report has been prepared in accordance with the EPA "Guidance for Performing Preliminary Assessments under CERCLA" (EPA, 1991). This report includes information obtained from review of federal, state, and local files, and the site reconnaissance visit conducted August 3 and 4, 2017 at selected mine sites.

1.1 PROJECT OBJECTIVES

The purposes of this PA are to:

- Summarize and evaluate existing historical information and analytical data.
- Assess presence, quantity, or absence of mine related contaminants in the AF Canyon area.
- Identify the potential human and ecological 'targets' that may be impacted, and potential and actual contaminant migration pathways.
- Evaluate if the potential source areas pose a threat to human health and the environment.
- Identify data gaps or limitations of existing data reviewed in this PA.

1.2 PROJECT SCOPE

The assessment includes reviewing readily available information and conducting a site reconnaissance visit (including photo documentation of site features), evaluating data to determine potential hazards using EPA Hazard Ranking System (HRS) criteria and other human health and environmental benchmarks, and identifying potential need for further investigation or emergency response actions.

2.0 SITE BACKGROUND

2.1 LOCATION

The site is located in Utah County, UT, within the Wasatch Mountains of the Uinta National Forest (See Figures 1 and 2). The geographical coordinates at the Tibble Fork Reservoir and the approximate center of the AF Canyon are 40.482700 latitude and -111.643086 longitude. The closest permanent residences are located approximately 370 feet from the American Fork River at the mouth of American Fork Canyon. The cities of Highland and Cedar Hills border the mouth of the canyon while the American Fork River passes through these cities as well as the City of American Fork before terminating at Utah Lake.

From the city of Highland, UT, access to the AF Canyon area is via Highway 92 (Highland Highway/W 11000 N) east into the American Fork Canyon where it turns into Alpine Loop Scenic Byway (closed in winter). A Trip Report with photographs of the mine areas visited in the AF Canyon during the August 2017 site reconnaissance visit is presented in Appendix A.

2.2 SITE DESCRIPTION

For the purposes of this investigation, the approximate boundaries of the Upper American Fork Canyon and Middle American Fork Canyon subwatersheds are approximately 38,539.26 acres (Figure 2). The elevation within the area of AF Canyon ranges from approximately 5,000 feet (ft) above mean sea level (amsl) at the mouth of the canyon to 11,489 amsl at Twin Peaks (U.S. Forest Service [USFS], 2002a). Topography around AF Canyon is generally steeply sloped mountainous terrain with narrow canyon bottoms followed by high, steep canyon walls (USFS, 2002a). The northern edge of the AF Canyon is bordered by Snowbird Ski & Summer Resort (Snowbird) (also present within the AF Canyon boundaries), Alta Ski Area, and Brighton Resort, with Solitude Mountain Resort adjacent to the north. Park City Mountain ski area is located approximately 4.5 miles northeast of AF Canyon. The east-southeast side of the AF Canyon is bordered by the Wasatch Mountain State Park with the southern end of the AF Canyon is bordered by the cities of Highland and Cedar Hills. The west-northwest side of the AF Canyon is bordered by the Uinta National Forest (Figure 2). Regionally, AF Canyon is bounded to the west-northwest by the Salt Lake Valley, to the north by the Wasatch Mountain Range, to the east by Heber Valley, to the southeast by the Provo River, and to the southwest by Utah Lake.

The AF Canyon area contains numerous abandoned mines with adits, shafts, prospect pits, waste rock and tailings piles, and historic mining structures. The USFS conducted inventories of mine features within the AF Canyon area for the Utah Division of Oil, Gas, and Mining (DOGM), including adits/portals, shafts, and prospects, between 1989 and 1995 (Cirrus, 2016a). A list of inventoried open adits, draining status, associated mines, and clean-up status associated with this PA are presented by drainage, from upstream to downstream, in Table 1 and are shown on Figure 3. The only active mining claims within the AF Canyon area are located within Township 4 South, Range 3 East, Sections 5 and 8 on USFS lands. There are 6 active lode claims within these sections identified as Big Dane No. 1 through Big Dane No. 6 (Mueller, 2017; BLM, 2017). The AF Canyon area contains several high mountain lakes with Pittsburg Lake residing near the headwaters of the American Fork River.

There are also two reservoirs in the AF Canyon area. They are the Tibble Fork Reservoir and Silver Lake Flat Reservoir, lying near the approximate center of the AF Canyon (Figure 2). The Tibble Fork Reservoir stores water from the American Fork River while the Silver Lake Flat Reservoir lies on Silver Creek, a tributary to the American Fork River, located approximately 1.4 miles upstream of Tibble Fork Reservoir. There are residences located throughout the AF Canyon area with the majority (38 residences) located in the Tibble Fork Recreation Residence Tract just south of the Tibble Fork Reservoir and the Silver Lake Tract (13 residences). Several others are scattered throughout in remote areas. The residences at Tibble Fork Reservoir and Silver Lake are authorized under special use permits from the USFS and are occupied by summer and/or recreational residents (USFS, 2008). In addition, the AF Canyon area is home to the Timpanogos Cave National Monument, Lone Peak and Mount Timpanogos Wilderness, and several campgrounds and hiking trails, a majority of which are located in the southern half of AF Canyon.

The properties within and surrounding the AF Canyon are comprised of a mix of privately-owned and USFS land. There is potential for future development within AF Canyon and in surrounding areas. Currently, Snowbird has installed two lifts and some ski runs in Mineral Basin (MB) and has developed hiking, mountain biking, horseback riding, guided skiing, cross-country skiing, snowcat skiing, snowmobiling, all-terrain vehicle (ATV) tours, and associated trail development in MB, Mary Ellen Gulch (MEG), and Miller Hill (MH) areas of the AF Canyon (Snowbird, 2015). In addition, in 2016, the Utah County Board of Adjustment approved Snowbird's request for a Conditional Use Permit (CUP) to add two additional ski lifts in MEG (one with incorporated zip line) and realignment of an existing MB lift, with associated ski runs, a new Ski Patrol facility on Hidden Peak, a new lift equipment facility in MB, two new skier warming huts in MEG, and seven avalanche control devices in MB and MEG (Utah County Board of Adjustment, 2016). These areas are present in an area designated by Utah County as Critical Environmental Zone (CE-1) and lie within the Urban Wildland Interface (Utah County Board of Adjustment, 2016).

Primary uses of the AF Canyon consist of motor vehicle sightseeing, ATV and Jeep riding, fishing, exploring mine sites, fishing, picnicking, hiking, camping, hunting, equestrian riding, and private uses for activities associated with the Snowbird resort. Heavy use is made of the streams and old mine sites (USFS, 2002a). Over 1.2 million visitors pass through fee collections stations on the Alpine Loop Scenic Byway each year for recreational purposes (USFS, 2002a). Of that, only an estimated 5% venture up the canyon past Dutchman Flat (USFS, 2002a), which is where the majority of the mines evaluated in this PA are located.

2.2.1 Climate

According to the Western Regional Climate Center (WRCC), there is a meteorological data station (#420072) in Alta near the top of the American Fork Canyon. The Alta data station is located approximately 1.4 miles northwest of the top of the mining district and approximate investigation boundary and monthly climate data is available from March 17, 1905 through June 9, 2016. Average winter temperatures in the upper reaches of the canyon range from 17 °F to 34.2 °F and average summer temperatures range from 40.3 °F to 61.4 °F (WRCC, 2016a). The average annual high temperature is 47.8 °F (WRCC, 2016a). Average annual precipitation is 53.97 inches with most precipitation occurring during the winter season (WRCC, 2016a).

There is a meteorological data station (#428733) near the bottom of the American Fork Canyon at Timpanogos Cave. The Timpanogos Cave data station is located approximately 2.6 miles northeast of the bottom of the approximate investigation boundary, and monthly climate data is available from December 1, 1946 through April 30, 2016. Average winter temperatures in the lower reaches of the canyon range from 26 °F to 45.5 °F and average summer temperatures range from 48.9 °F to 78.3 °F (WRCC, 2016b). The average annual high temperature is 61 °F (WRCC, 2016b). Average annual precipitation is 24.78 inches with most precipitation occurring during the winter season. Prevailing winds in the Salt Lake area (approximately 30 miles north-northwest of AF Canyon) are generally to the south-southeast (WRCC, 2016b).

2.2.2 Vegetation and Wildlife

Vegetation in and around the AF Canyon includes a variety of grasses, wildflowers, shrubs and trees characteristic of the Utah mountain environments. The canyon consists of several plant communities including riparian, coniferous, mountain-brush, and sub-alpine (National Park Service [NPS], 2017). The north-facing slopes of the canyon consist of coniferous forest, while the south-facing slopes consist of Gambel oak and meadows (Utah Division of Wildlife Resources [UDWR], 2017). Alpine tundra begins above 10,000 feet with low shrubs, grasses and herbs (USFS, 2002a). Cottonwoods, box elder maples, aspen, Gambel oak, bigtooth maple, rabbitbrush, Mexican cliffrose, Douglas and white fir, mountain bluebells, firecracker (Eaton's), purple penstemons, and wild onion can all be found in the various communities within the canyon (NPS, 2017).

Wildlife in the area includes mountain goats, Rocky Mountain bighorn sheep, mule deer, elk, black bear, moose, mountain lion, marmot, beaver, bald eagle (State of Utah Wildlife Species of Concern), Townsend’s big-eared bat (State of Utah Wildlife Species of Concern), northern goshawk, flammulated owl, peregrine falcon, three-toed woodpecker, and greater sage grouse (State of Utah Wildlife Species of Concern). Fish species found in the area of the site include Bonneville cutthroat trout (sensitive species), mottled sculpin, mountain sucker, brook trout, brown trout, and rainbow trout. (UDWR, 2017; Seager, 2017; USFS, 2002a).

2.2.2.1 Threatened and Endangered Species

A search of the U.S. Fish & Wildlife Service (USFWS) Environmental Conservation Online System (ECOS) Information, Planning, and Conservation (IPaC) System, and the Utah Natural Heritage Program’s (UNHP) Biodiversity Tracking and Conservation System (BIOTICS) indicates six different species (one bird, one fish, two flowering plants and two mammals) are potentially present in the area of the site that are considered federal or state listed threatened or endangered species (USFWS, 2017a; 2017b, UNHP, 2015). The following species are potentially associated with the study area:

- Yellow-billed Cuckoo *(Coccyzuz americanus)* (Threatened)
- June Sucker *(Chasmistes liorus)* (Endangered)
- Jones Cycladenia *(Cycladenia humilis var. jonesii)* (Threatened)

- Ute Ladies'-tresses *(Spiranthes diluvialis)* (Threatened)
- Canada Lynx (*Lynx Canadensis*) (Threatened)
- Brown (Grizzly) Bear *(Ursus arctos)* (State Listed)

A site-specific biological assessment has not been performed; therefore, it is currently not possible to determine if any of these species are definitively present in the AF Canyon area. According to the USFWS ECOS none of the aforementioned species have designated critical habitat, which would confirm presence, within the area of the AF Canyon. Of these species, only the Jones cycladenia is not known or believed to occur within the area of the investigation (USFWS, 2017a; 2017b). The above list is not to be considered a comprehensive list of possible threatened and endangered species that may be present in the AF Canyon area.

2.3 SITE HISTORY

2.3.1 Operational History

Mining in the AF Canyon and surrounding area began in the American Fork Mining District located in the northeast portion of American Fork Canyon, Utah County, Utah, at the headwaters of the American Fork River (Figure 4) (Ercanbrack, 1970; Hill and Lindgren, 1912). The mining district encompassed the area from the headwaters to just downstream of Deer Creek, a tributary to Tibble Fork Reservoir, and included confluent canyons such as MEG, Shaffer Fork, Dry Fork, and Major Evans Gulch and operated from 1870 through the early 1920's (Ercanbrack, 1970).

Mining of the canyon began in 1870 with the discovery of silver- and lead-bearing ore in the southern canyon, known as the Sunbeam Lode, which resulted in the formation of the American Fork Canyon Mining District (Shelley, 1945; Raymond, 1872). The first mine to begin operations in the district was the Miller mine (a.k.a. Miller Group, Miller Mining and Smelting Co., and Wyoming Tunnel), located southeast of Mineral Flats, in September, 1870 (Huntley, 1885). Other significant mining operations included the Pittsburg (a.k.a. Pittsburg Consolidated M. and M. Company), Pioneer, Wild Dutchmen (a.k.a. Dutchman, Dutchman Coalition Mines Co.), Mountain Lion, Pacific (a.k.a. Pacific Gold Mining and Milling Co., Blue Rock), and Silver Glance (Ercanbrack, 1970). "During the first year of operation, the Miller mine produced 1000 tons of bullion, which sold in the East for $250 per ton" (Ercanbrack, 1970; Murphy, 1872). The successful production at this mine served as the basis for the organization of the first mining company in the district (Aspinwall Company) (Utah Mining Gazette, 1874).

In 1871, the Apsinwall Company purchased the Miller mine and began building a smelter (Sultana Smelting Works a.k.a. Sultana Smelter) and a mining town (Forest City) (Utah Mining Gazette, 1874; Ercanbrack, 1970; Shelley, 1945). The smelter was constructed for the purpose of reducing ore from the Miller mine and consisted of three reduction furnaces (Ercanbrack, 1970; Murphy, 1872; Utah Mining Gazette, 1874). The smelter was located 2.5 miles below and southeast of the mine and ore from the mine was transported via tramway to the smelter (Murphy, 1872; Utah Mining Gazette, 1874). The company also contracted with C.B. Hawley and Company to build housing facilities for the miners and smelter workers (Ercanbrack, 1970). The result was Forest

City, which at its boom supported two hotels, a large store and at least one saloon (Murphy, 1872; Shelley, 1945; Salt Lake Daily Tribune and Utah Mining Gazette, 1873).

May of 1872 saw the beginning of the construction of a railroad connecting Sultana Smelting Works to American Fork City by the company; however, the company quickly reorganized itself in order to gain capitol to complete the endeavor and became the Miller Mining and Smelting Company with the inclusion of additional investors (Ercanbrack, 1970; Utah State Archives; Utah Mining Journal, 1872). From this came the American Fork Canyon Railroad Company which organized to serve the Sultana Smelting Works, the Miller Mining and Smelting Company, and other interested groups within the district (Wain, 1949). The company constructed two new reduction furnaces at Deer Creek, 15 stone charcoal kilns near the Sultana smelter and 10 near a new smelting works at Deer Creek in an effort to reduce transportation costs during construction of the railroad (Murphy, 1872; Utah Mining Journal, 1872; Ercanbrack, 1970). These furnaces were large enough to almost continuously supply enough charcoal for many of the Salt Lake smelters from 1872 to 1877 (Huntley, 1885; Croffut, 1873). With the railroad completed, the district saw its peak boom in the years from 1873 to 1875 (Ercanbrack, 1970).

The American Fork Mining District saw a total production amount of $2,630,700 between 1870 and 1880 producing 60% of the total county revenue from precious-metal mining and making it one of the most significant economic contributors in the territory (Butler et. al., 1920; Ercanbrack, 1970). Commodities from the district included copper, gold, lead, silver and zinc (Hill and Lindgren, 1912). The Pittsburg, Sunday, Silver Bell, Orphan, Queen of the West, Live Yankee (a.k.a. Yankee, Belorophan, Mary Ellen, and West Extension), Whirlwind, Noncompromise, Milkmaid, and Wasatch King were the other producers prior to 1880 (Calkins et. al., 1943). Between 1876 and 1917, the Dutchman mine (a.k.a. Dutchman Coalition Mines Co. and Wild Dutchman) was worked intermittently and some ore milled in a 100-ton concentration plant, erected by the Fissures Exploration Co. at the portal of the Dutchman tunnel. The concentrator was subsequently dismantled and re-erected at the mouth of the Pacific (Blue Rock) tunnel (Calkins et. al., 1943). However, due to old mining methods, antiquated equipment, and the diminishment of rich veins and high-grade ore, the district began to see decline in the fall of 1875 (Ercanbrack, 1970). Of the largest mines particularly affected by the complete loss of ore were the Miller, Wild Dutchmen, Pittsburg, and Vermillion mines. In June, 1876 the Sultana smelter closed operations (Huntley, 1885; Butler and Loughlin, 1915). By December, 1876 the Miller, Wild Dutchman, and Pittsburg mines shut down completely (Huntley, 1885; Butler and Loughlin, 1915). Some mines ceased operations before the veins gave out due to high continuing operational costs (Huntley, 1885). Some of the smelters were dismantled and large amounts of lead were salvaged from the bottoms of the furnaces (Huntley, 1885). The railroad also became unprofitable with the American Fork Canyon Railroad Company ultimately removing the tracks and selling them to the Utah and Pleasant Valley Railroad Company for use on the Spanish Fork Canyon line in 1878 (Huntley, 1885; Huff, 1947; Butler et. al., 1920). The ultimate end to the most significant mining effort came in 1880 when Forest City burned down during a lighting storm and a reservoir damn in the canyon broke, removing all remaining supply sheds and the road (Western Mining Gazetteer, 1880; Butler et. al., 1920; Shelley, 1945).

Between 1881 and 1900 development work was done and included employing about 150 men in 1892 to clean out the mines, retimber the shafts and tunnels, and reconstruct the road up the canyon to the mines; however, these efforts were met with failure due to insufficient quantities of valuable ore in the mines (Utah: Her Cities Towns and Resources, 1892; Ercanbrack, 1970). In 1886, the aggregate shipments of the Belorophon, Live Yankee, Milkmaid, Miller, Silver Bell, Sultana, Wild Dutchman, and E. H. Bailey & Co. amounted to only approximately 80 tons (Calkins et. al., 1943). In 1891 the Wild Dutchman, North Star, Kalamazoo, and Live Yankee properties yielded an aggregate of only 100 tons of ore (Calkins et. al., 1943). It wasn't until 1904 when George Tyng, who was leasing the old Miller mine, uncovered a new body of rich ore and started a second mining boom (Shelley, 1945). However, as with the first boom came the use of obsolete methods and equipment and low-grade ore resulting in the gradual decline in production between the years of 1908 and 1914 (Ercanbrack, 1970).

One additional boom occurred when a group of geologists performed a reconnaissance of the area and reported the existence of an enormous system of parallel mineralized fissures which traversed the district (Butler and Loughlin, 1915; Ercanbrack, 1970). These fissures had not been explored at this point due to shafts and tunnels either being too shallow or leading away from the fissures (Ercanbrack, 1970). With the companies able to strategize reaching the available ore now, they turned to new technologies and mining techniques which included operations, drills, mills, pumps and other equipment that utilized electrical power (Ercanbrack, 1970). In 1916, the Utah Power and Light Company built a power line from its Snake River Creek electric power plant, over the divide, to the center of the district (Ercanbrack, 1970; Shelley, 1945; American Fork Citizen, 1916). Production in the district rose, but was halted once again when the veins turned out to be shallower than anticipated and gave out quickly (Ercanbrack, 1970). By the end of 1918 production had declined and continued to do so through the early 1920s when most companies dissolved and lessees took over operations in those mines that were still workable (Ercanbrack, 1970; Shelley, 1945). Mining in the district continued into the 1950s with some recreational dredge mining taking place in the early 2000s. A timeline summary of the operational history is provided in the Table 2-1.

Table 2-1 – American Fork Mining History

Date	Summary
1870 – 1875	The American Fork Mining District was formed with a smelter, two reduction furnaces at Deer Creek, tramway, mining town (Forest City), and railroad were developed.
1875-1880	Mining district began to see decline in the fall of 1875 with some mines and the smelter ending operations. The railroad was dismantled and Forest City burned down.
1880-1900	Efforts were made to redevelop the mines; however, efforts failed due to lack of valuable ore in the mines.
1900-1920s	A new body of rich ore was uncovered at the Miller mine in 1904; Production declined between 1908 and 1914; Additional efforts were made, but gradual decline continued.
1920s-1950s	Sparse mining in the district continued into the 1950s.

2.3.2 Investigations and Regulatory Involvement

Numerous investigations and regulatory actions have taken place in AF Canyon area over the past several decades. They indicate that the mines contributing most of the heavy metals loads to the MEG creek and American Fork River are the Pacific, Lower Bog, and Mary Ellen mines (a.k.a.

Live Yankee, Yankee, Belorophan, and West Extension). The following is a brief summary of these past activities:

USFS - Preliminary Survey of Water Quality in Mine Drainage in Sheeprock Mountains and North Fork of the American Fork River (1988) and USFS - Memorandum (1989) - Water samples collected from the Miller Hill tunnel on the American Fork River were determined to be of very good quality with essentially no heavy metals and no need for further assessment (Merritt, 1988). Assessments of macroinvertebrates and water quality conducted in 1988 and 1989 in the American Fork Canyon and other mined areas of the Uinta National Forest indicated that localized stream pollution occurred on the North Fork of the American Fork River below the Lower Bog Mine and on the Pacific Mine and MEG below mined areas on the west side of the drainage (Magnum, 1988; Skabelund, 1989).

Utah Division of Environmental Response and Remediation (DERR) - Technical Memorandum (1991) - In 1990, Utah DOGM recommended mitigating the Pacific and MEG mine sites by either routing runoff around the tailings and dump sites or moving material to a lower precipitation site with their preferred method being to reroute runoff (Trueman, 1991). In 1991, the Utah DERR requested inclusion of the site (comprised of Pacific, Lower Bog and Mary Ellen mines [collectively known as the American Fork Canyon/Uinta National Site]) in the Comprehensive Environmental Response, Compensation, and Liability System (CERCLIS) due to hazardous substances that appeared to be present on the site from these mines (Trueman, 1991).

Cirrus Ecological Solutions LC (Cirrus) - Memorandum (2016) and Snowbird – Final Water Quality Monitoring Plan for Mary Ellen Gulch Creek, American Fork Canyon (2016) – The American Fork Canyon/Uinta National site was entered into CERCLIS in 1992 (Cirrus, 2016b). Studies by DOGM and USFS (discussed in subsequent sections of this report) resulted in the EPA issuing a No Further Remedial Action Planned (NFRAP) in 1995 due to a lack of targets and sole recreational use of the mine areas in the Uinta National Forest (i.e., the site posed little or no threat to human health and the environment) (Cirrus, 2016a; EPA, 1995a). The CERCLIS site was archived in 2003 (Cirrus, 2016b). It was moved to active status in 2005 due to concerns by the USFS about the Pacific Mine (Cirrus, 2016b). The Pacific Mine repository was completed in 2006 and the NFRAP status remained until 2016 when it was moved to the PA ongoing status for the current PA (Cirrus, 2016b; EPA, 2016).

USFS - Heritage Resource Inventory of American Fork Area Mine Closures, Utah County, Utah (1994) - An inventory of mines in the American Fork Canyon and surrounding area was conducted by the USFS for the DOGM's Abandoned Mine Reclamation Program in the summer of 1992. The purpose of the inventory was to determine appropriate mine closure methods in an effort to ensure public safety and determine eligibility of sites for the National Register (Crosland and Thompson, 1994). Numerous mines within the American Fork Canyon were documented to contain waste piles as shown in the inventory summary table presented in Appendix B (Crosland and Thompson, 1994). Some additional inventories and closure activities were also completed by the DOGM in 1994 and 1995.

University of Wyoming – Year End Report on Mitigation Systems for Hard Rock Mine Effluent in Utah (1992) - An assessment was conducted at the Mary Ellen and Pacific mine sites in 1992 to evaluate wetland plants to determine which species would sequester and could tolerate heavy metals associated with mine water discharge in an effort to aid in design and construction of wetlands (Kastning-Culp, et. al., 1992). The study identified six species of plants that would accumulate heavy metals and improve water quality (Kastning-Culp, et. al., 1992). Two species accumulated the highest levels of arsenic, copper, and zinc. The assessment concluded that wetlands on the MEG site may improve water quality by retaining metals (Kastning-Culp, et. al., 1992).

DOGM - Memorandum (1993) - According to a 1993 letter from the Utah DOGM, the Pacific mine needed reclamation, but none was needed at the Lower Bog mine due to inaccessibility, limited magnitude of the problem, and high dilution ratios (Mesch, 1993). The letter indicated that based on the small areal extent of the Miller Hill tailings pile and ease of access, removal may be the best alternative (Mesch, 1993). The letter concluded that further investigation was needed in MEG before any reclamation alternatives could be recommend (Mesch, 1993).

DOGM and USFS – American Fork Hydrology and Water Quality Study (1993) - During the same year, the Utah DOGM and the USFS conducted an investigation on the receiving waters of the Uinta National Forest for water quality impacts from discharges from the mines in MEG, Pacific mine, and the Lower Bog mine. The study indicated that concentrations of cadmium, copper, iron, lead, and zinc in Mary Ellen Creek downstream of the mines exceeded the Utah Rule 317-2 Standards of Quality for Waters of the State, 3A water quality standards; however, the exact source of the contaminants could not be determined due to the minimal number of sample points collected (Lidstone & Anderson, Inc., 1993). Further sampling was recommended to determine sources (Lidstone & Anderson, Inc., 1993).

USFS – Preliminary Assessment, American Fork Canyon, Pacific Mine, Mary Ellen Gulch Mine, Lower Bog Mine (1994) - In 1994, the USFS completed a PA on the MEG, Pacific, and the Lower Bog mines. Each mine contained tailings piles and adit drainage containing elevated levels of copper, cadmium, and zinc (USFS, 1994). The Pacific mine was heavily used by recreationists and the Lower Bog and Mary Ellen are accessible (USFS, 1994). Water from all three mines enters the American Fork River (USFS, 1994).

Snowbird – Final Water Quality Monitoring Plan for Mary Ellen Gulch Creek, American Fork Canyon (2016) and USFS – American Fork Canyon – Water Samples (No date) – Following remediation efforts at the Live Yankee Adit No. 1 (a.k.a. Live Yankee north adit) at the Mary Ellen mine, which included re-routing the adit drainage around the tailings piles (Cirrus, 2016b), the USFS again conducted water quality sampling at abandoned mines in the North Fork of American Fork Canyon and MEG in 1998. Again, dissolved concentrations of lead and zinc in surface water samples collected below the Mary Ellen mine site exceeded Utah Rule 317-2 Standards of Quality for Waters of the State, 3A water quality standards (Cirrus, 2016a; USFS, 1998).

USFS – Mary Ellen Phase I (2000) - Following the 1998 sampling, the USFS contracted Cirrus to conduct a Phase I Environmental Site Assessment (ESA) on mines located on several claims in MEG in 1999 (Cirrus, 2016a). The 2000 Phase I ESA report identified several recognized environmental conditions including the Quartzite, Silver Wave, Powers, and Mary Ellen claims (Cirrus, 2016a). These recognized environmental conditions also included mine portals discharging water on the Quartzite, Silver Wave, and Powers claims, mainly the Mary Ellen north portal on the Quartzite claim (Cirrus, 2016a). Recommendations were made to collect water and soil samples as part of a Phase II ESA (Cirrus, 2016a). This report was not ascertainable during the completion of this PA and the above synopsis was synthesized from a Cirrus memorandum.

USFS – Mary Ellen Phase II (2000) - Cirrus conducted the Phase II ESA and collected 11 soil samples and 10 water samples from tailings piles and streams (Cirrus, 2016a). All 11 soil samples collected from tailings piles had concentrations of arsenic that exceeded both the Residential and Industrial Risk-Based Contaminant (RBC) criteria (Cirrus, 2016a). In 10 of the 11 samples, lead exceeded the RBC (Cirrus, 2016a). Six samples were collected from the piles and analyzed for soluble metals concentrations used to determine if a waste is hazardous (Cirrus, 2016a). Of these, five samples exceeded the soluble metal criteria for lead used to assess potential disposal requirements (Cirrus, 2016a). As a result, the piles in their current location and condition were only considered a solid waste (Bevil exclusion) and would not be classified as hazardous waste unless removed from the site for disposal (Cirrus, 2016a). Five of the 10 samples collected from waters in MEG exceeded the one-hour Class 3A standard for various metals (Cirrus, 2016a). The most upstream sample contained the highest dissolved concentrations of aluminum and copper with an elevated zinc concentration (Cirrus, 2016a). Discharge from the Mary Ellen north adit just above the confluence with Mary Ellen Creek only exceeded for zinc (Cirrus, 2016a). The report concluded that, in general, the 1999 concentrations collected in this Phase II study were lower than those detected in previous studies by the USFS in 1998 and Lidstone and Anderson in 1993 (Cirrus, 2016a). It was not known whether the observed differences were related to seasonal variations in stream flow and precipitation, or indicated a true decrease in metals concentrations over time (Cirrus, 2016a). This report was not ascertainable during the completion of this PA and the above synopsis was synthesized from a Cirrus memorandum. Therefore, it is unknown if these samples were included in a separate report or database as secondary data evaluated in this PA.

USGS - Methods and Basic Data from Mass-Loading Studies in American Fork, October 1999, and Mary Ellen Gulch, Utah, September 2000 (2009) - The United States Geological Survey (USGS) conducted mass loading studies in the American Fork Canyon and MEG. Water quality and flow measurements were collected along a 10,000-meter reach of the American Fork River and nearly 4,500-meter reach of MEG during low-flow periods (fall) in 1999 and 2000 to define contributions that enter the stream continuously (Kimball et. al., 2009). Sampling in MEG identified large contributions of iron and zinc from the Yankee Mine and associated tailings piles (Cirrus, 2016a; Kimball et. al., 2009). Loading to the American Fork River from groundwater inflow downstream from MEG was significant and, based on the 2000 study, the same groundwater contribution was the most substantial metal loading in MEG for several metals [copper, iron, and manganese] (Kimball and Runkel, 2009).

Cirrus - Memorandum – Summary of Studies – Soil and Water Resources in Mary Ellen Gulch (2016) - Samples collected by Lidstone and Anderson in 1993 at approximately 1,000 feet below MEG North portal discharge were compared to samples collected in the USGS study (2000) from the same location. This comparison showed dramatic reductions in all metals concentrations between 1993 and 2000 and all samples collected during the USGS investigation met State water quality standards (Cirrus, 2016a). Improved water quality conditions in Mary Ellen Creek downstream of the Live Yankee Adit No. 1 discharge were the result of rerouting flows away from the tailings pile in 1997 (Cirrus, 2016a and 2016b; Kimball et. al., 2009). Based on the comparison of results from these reports, Cirrus concluded there was heavy metal loading occurring in MEG;

however, when the discharge from Live Yankee Adit No. 1 was rerouted, there was no need for further clean-up (Kimball and Runkel, 2009; Cirrus, 2016a). In addition, as long as the Quartzite tailings piles were not disturbed by development, the diversion of flows from the Live Yankee Adit No. 1 kept away from the tailings, or there was no summer traffic on those tailings, there should be no cause to revisit the decision that no further clean-up was needed (Cirrus, 2016a).

Snowbird – Final Water Quality Monitoring Plan for Mary Ellen Gulch Creek, American Fork Canyon (2016) - In 2008, Snowbird and Trout Unlimited installed a more permanent drainage system at the Live Yankee Adit No. 1 (Cirrus, 2016b).

USFS – American Fork Canyon, Uinta National Forest, American Fork Canyon, Utah, Watershed Restoration Evaluation (2001) - In October 2000, USFS and their contractor Science Applications International Corporation (SAIC) and U.S. Bureau of Reclamation (USBR) conducted reconnaissance of impacted areas within the district, collected X-ray fluorescence (XRF) analyses of selected waste rock piles to determine contaminants present and their concentrations, and field parameters used to model erosion of mining areas, roads, trails, and recreational areas which they used to develop recommendations for restoration (SAIC, 2001). The tailings and waste rock piles were determined to contain concentrations of arsenic, cadmium, lead and mercury that posed a threat to human health and the environment (SAIC, 2001). As a result, the USFS implemented a CERCLA Time-Critical Removal Action (TCRA) for the two tailings piles located on public land associated with the Pacific mine and Dutchman Flat to be removed and consolidated in a central repository located across the American Fork River from the Dutchman mine (SAIC, 2001). Waste rock piles associated with the Blue Rock and Wild Dutchman mines were also to be removed and deposited with the Pacific mine and Dutchman Flat tailings (SAIC, 2001). SAIC identified the Bog, Bay State and Scotchman mines waste rock piles as having the highest risk to campers and ATV riders due to their elevated metals concentrations, accessibility and frequent use (SAIC, 2001). A risk to ATV drivers for exposure to arsenic and lead were present at the Wyoming tunnel, Alpine mine, and Midwest tunnel sites (SAIC, 2001). The sites posing the greatest risk to ecological targets were the Bog and Bay State mine sites for exposure to arsenic, lead, and zinc (SAIC, 2001). Although the risk to ecological targets due to exposure to metals in the waste rock piles at the Miller Hill Tunnel and Scotchman mine are slightly less due to reduced concentrations, their proximity to American Fork River make them attractive to wildlife (SAIC, 2001).

USFS – Engineering Evaluation & Cost Analysis (EE/CA) for American Fork Canyon Mine Reclamation Project (2002) - In 2000 and 2001 the USFS installed rock and/or fence barriers and signs at the Pacific (under a TCRA), Dutchman Flat and Sultana Smelter to prevent vehicle access to the sites to reduce public exposure to heavy metals (USFS, 2002a). In 2001, the proposed repository location for the Pacific mine and Dutchman Flat tailings was abandoned due to a high water table discovered there in the spring of 2001 and moved to the bench at Dutchman Flat (USFS, 2002a).

EPA (2001) - Tetra Tech, a contractor to the EPA, completed an endangerment assessment on the Pacific mine (consisting of the Pacific mine waste pile, Pacific Mill and Pacific Mill tailings ponds) and Dutchman Flats (consisting of mill site, mine waste dump, and tailings pond) sites in 2001. The assessment concluded that soil and mine waste (tailings) containing metals presented imminent health risks to the public and the environment at the Dutchman Flats and Pacific mine sites (Damian, 2001). Recreationists accessing these areas were expected to encounter unsafe exposure to lead and arsenic through inhalation, dermal and/or ingestion means (Damian, 2001). Comparison of Preliminary Remediation Goals (PRGs) to levels of lead and arsenic detected in site soils and tailings materials indicated that many areas of these sites were considered unsafe for recreational use (Damian, 2001). Levels of lead, arsenic, and zinc were elevated in fish collected downstream of these sites (Damian, 2001). However, these levels were still less than available safe levels (guidance levels) established by Food and Drug Administration (FDA) for metals in seafood (Damian, 2001). Reduced macroinvertebrate populations downstream of these sites and significant exceedances of EPA ambient water quality criteria (AWQC) for zinc, lead, and cadmium indicated that metals-contaminated mine runoff were adversely affecting stream fauna in the American Fork River, and tributaries of the American Fork River (Damian, 2001).

<u>USFS – Engineering Evaluation & Cost Analysis for American Fork Canyon Mine Reclamation Project (2002)</u> - Due to federal funding restrictions following the 9/11 attacks on the United States in November 2001, the EPA had to withdraw from participating in removal actions in the American Fork Canyon and suggested the USFS proceed with removal actions on USFS lands as their funding allowed (USFS, 2002a). As a result, in 2002 the USFS abandoned the TCRA for the American Fork Canyon and conducted an EE/CA for a non-TCRA to begin in 2002 (USFS, 2002a). The EE/CA concluded that Dutchman Flat provided sufficient area to construct a repository large enough to cover the Dutchman mine tailings and include all of the waste from the Pacific, Bay State, and Wild Dutchman mines, Dutchman Mill site and the Sultana Smelter (USFS, 2002a). During this time, the Utah Division of Water Quality (DWQ) notified the USFS that the North Fork of the American Fork River would be listed as a 303(d) impaired water by the State in 2002 and that a Fish Advisory would be issued to inform the public not to consume fish (browns and cutthroats) from the stream (USFS, 2002a).

<u>Utah Department of Environmental Quality – Utah Lake – Jordan River Watershed Management Unit Stream Assessment (2002)</u> – A fish consumption advisory for arsenic was issued by the Utah Department of Environmental Quality (UDEQ), the State Department of Health and the Utah County Health Department for the North Fork American Fork River and tributaries upstream of Tibble Fork Reservoir in 2002 (UDEQ, 2002). The health advisory resulted in that segment of the river being listed as impaired for arsenic (UDEQ, 2002). The lower portion of the American Fork River and its tributaries from Tibble Fork Reservoir to the diversion at the mouth of the canyon were listed as impaired for pH, as that segment of the river exceeded the State Standard of 9.0 for pH (UDEQ, 2002).

<u>EPA – Final Report, Yankee Mine Site, Utah County, Utah (2002)</u> - In 2002, the EPA conducted a Removal Assessment of the tailings piles at the Yankee mine, Globe mine, Scotchman, and Plume L-94 (a.k.a Silver Wave Adit 1 waste pile) (Lockheed Martin/Response Engineering and Analytical Contract [REAC], 2002). Surface water from MEG, springs, seeps, and mine drainage were also assessed. The assessment concluded that concentrations of arsenic, lead, and zinc were present in both the tailings and soil collected on the site and that contamination was not isolated to the tailings piles, but was widespread both on and off the tailings piles (noting that one sample location off the tailings piles adjacent to MEG appeared to be used as a campsite) (Lockheed Martin/REAC, 2002). XRF results of the tailings at Plume L-94 had the highest average zinc concentrations (4,328 milligrams/kilogram [mg/kg]), Yankee (north tailings pile) had the highest

average arsenic (194 mg/kg), and Globe had the highest average lead concentrations (3,543 mg/kg) (Lockheed Martin/REAC, 2002). Results from the adit discharge collected from a source upgradient of the Yankee mine tailings pile had elevated concentrations of arsenic and zinc (Lockheed Martin/REAC, 2002). A sample collected after flowing 150 feet down gradient over the tailings pile and combined with a second adit discharge showed elevated concentrations of arsenic, copper, lead, and zinc indicating that the tailings were a source of metals contamination to MEG (Lockheed Martin/REAC, 2002). Two seep samples collected down gradient of the Yankee tailings pile also contained elevated levels of zinc and copper compared to springs samples collected upgradient of the tailings pile (Lockheed Martin/REAC, 2002). Surface water samples collected from MEG indicated increased metals concentrations after flowing across the Globe mine tailings pile and again after flowing downstream of the Yankee mine tailings pile (Lockheed Martin/REAC, 2002).

<u>USFS - Technical Memorandum (2002)</u> and <u>USFS – Photo Log (2003)</u> - In 2002/2003, the USFS completed a removal of the Dutchman, Wild Dutchman, and Bay State waste rock piles, the Sultana Smelter wastes, Dutchman Mill wastes, and its portion of the Pacific mine tailings located on the North Fork of the American Fork River (USFS, 2002b; USFS, 2003). All contaminated waste rock, tailings, and soil were removed and placed in a repository at the Dutchman Flat site, capped with a composite liner and covered with native soil (USFS, 2002b; USFS, 2003). At Pacific mine, oxidizing ponds were developed in the reclaimed area and the mine drainage from the adit was diverted through these ponds to allow the precipitation and deposition of dissolved metals before entering the North Fork American Fork River (USFS, 2002b; USFS, 2003). In addition, the waste rock pile at Bog mine was capped in place and the adit drainage from Lower Bog mine diverted into a constructed treatment channel (USFS, 2003).

<u>UDEQ – Utah's 2004 303(d) List of Impaired Waters (2004)</u> - The health advisory for arsenic in fish tissue was removed and the need for a total maximum daily load (TMDL) rescinded in April 2004 (UDEQ, 2004). Currently there are no TMDLs for any streams or rivers within the AF Canyon.

<u>USFS – POLREP (2005, 2006)</u> and <u>USFS - Field Report (2005)</u> - Subsequent monitoring and sampling of the adit drainage from the Pacific and Lower Bog mines and American Fork River between 2004 and 2006 showed decreasing efficiency in the passive treatment systems due to the formation of iron-oxyhydroxide precipitates, which pacified their buffering capacities (Davidson, 2005a and 2006a). This allowed soluble iron and zinc to enter the American Fork River at concentrations exceeding 1-Hour acute and/or 4-Day chronic water quality standards (Davidson, 2005a and 2006a). However, in 2006 the Region IV Environmental Engineering, Water Systems and Hazmat office of the USFS recommended no further treatment of the Lower Bog mine adit drainage since zinc values in the American Fork River below the confluence with the adit drainage were below water quality standards (Davidson, 2006b). Seeps located beneath the waste rock pile at Pacific mine were discharging aluminum oxyhydroxide precipitates during the spring and early summer months with a pH of 3.4 and concentrations of aluminum, lead, zinc and mercury; however, flow from these seeps never reached the ponds (Davidson, 2005b).

<u>USFS – POLREP (2007)</u> - During the spring/summer of 2007, discharge from the Pacific mine adit was continually being blocked by beaver dams and diverted into the beaver pond away from

the treatment ponds (Davidson, 2007). Flow then went directly from the beaver pond into the North Fork American Fork River (Davidson, 2007). It was recommended that a pipe be installed from the uppermost pond into the Pond 1 inflow channel to prevent the beaver from further diverting the adit drainage into the beaver pond (Davidson, 2007). Soluble zinc from the discharge from Pond 4 exceeded the 1-Hour acute and 4-Day chronic state water quality standards for the 2007 spring sample; however, the 2007 fall sample was below (Davidson, 2007). pH levels in the adit drainage and Ponds 1 and 4 increased from the 2006 season (Davidson, 2007).

<u>Trout Unlimited – Final Construction Report, Trout Unlimited, American Fork Canyon Home Rivers Project (2006)</u> - The EPA oversaw a voluntary Removal Action on the private land portion of the Pacific mine site in 2006 (conducted by Snowbird and Trout Unlimited), encompassing approximately 3 acres, including the Pacific mine waste rock pile, the Pacific Mill site, the Blue Rock mine waste rock pile, and the Scotchman No. 2 mine waste rock pile (Fitzgerald, 2006). However, not all material was excavated from the Scotchman No. 2 mine site (Fitzgerald, 2006). The upper reaches of the pile could not be removed, as doing so would have undercut the MEG access road (Fitzgerald, 2006). XRF readings of waste material left in place had concentrations of lead at 580 parts per million (ppm) or less (Fitzgerald, 2006). Wastes from these sites were all deposited with the waste rock pile at the Pacific mine at what is now the Pacific repository, capped with a composite liner, and covered with native soil (Fitzgerald, 2006).

<u>Snowbird Ski & Summer Resort – Final Water Quality Monitoring Plan for Mary Ellen, Gulch Creek, American Fork Canyon (2016)</u> - As part of Snowbird's 2016 CUP and at the request of American Fork City, water quality monitoring in MEG has been conducted monthly since April 2016 to identify any impacts to water quality in the creek as a result of development in the MB due to resort expansion operations (Cirrus, 2016b). According to the plan, any degradation of water quality identified would provide a basis for clean-up actions (Cirrus, 2016b). Seven locations are sampled in MEG starting upstream of the mined area in MEG all the way down to above the confluence with the North Fork of the American Fork River (sample locations from upstream to downstream: 5992277, 5992274, 5912310 [Live Yankee Adit No. 1 discharge], 5912317, 5912320, 4995000, and 5912340) (Cirrus, 2016b). Samples are analyzed for a select list of dissolved metals and results compared by the State to the Utah "Standards of Quality for Waters of the State, R317.2" for violations of acute metal 3A standards based on Table 2.14.3b: 1-Hr Average (acute) concentration in micrograms per liter (µg/L) (Cirrus, 2016b). Monitoring results used in this PA are further discussed in Section 3.2.1.1.2. Sampling will continue on a monthly basis for a period of two years from April 2016 to establish a baseline (Cirrus, 2016b). Monthly sampling will occur through construction periods (Cirrus, 2016b). During intervals between construction periods and after construction is complete, samples will be collected on a quarterly basis (Cirrus, 2016b). The total monitoring period will be eight years beyond the end of construction unless a revised schedule is mutually agreed to by Snowbird and Utah County (Cirrus, 2016b).

A timeline summary of previous investigations and regulatory involvement in the AF Canyon is provided in the table below. A summary of mines features associated with this PA identified during the 1989-1994 inventory conducted by DOGM and indicated as "open", associated mines, clean-up actions, and feature drainage status are presented in Table 2-2.

Table 2-1 - American Fork Basin Mine Sites – Timeline of Investigations and Regulatory Actions

Date	Summary
1988-1995	Numerous studies conducted on impacts of mines to local drainages; Mine inventory conducted in the AF Canyon in 1992 with subsequent mine closures being completed in 1994-1995. The American Fork Canyon/Uinta National site was entered into CERCLIS 1992.
1991	Pacific/Lower Bog/Mary Ellen mines entered into CERCLIS. (Note: these sites fall under the umbrella of the current American Fork Canyon/Uinta National site and this PA)
1994	USFS completed a PA on the MEG, Pacific, and the Lower Bog mines and each contained tailings piles and adit drainage containing elevated levels of copper, cadmium, and zinc.
1995	NFRAP issued for the Pacific/Lower Bog/Mary Ellen mines Site. (Note: these sites fall under the umbrella of the current American Fork Canyon/Uinta National site and this PA)
1998	Following removal efforts at the Mary Ellen mine in 1997, sampling was conducted and surface water samples in MEG below the Mary Ellen mine (a.k.a Live Yankee) still exceeded State water quality standards for lead and zinc.
1999	Phase I ESA conducted at several claims in MEG; several recognized environmental conditions were identified. Phase II ESA conducted; concluded tailings and surface water samples collected from MEG exceeded risk-based and State water quality criteria for several metals.
1999-2000	Mass loading studies conducted by the USGS on the American Fork Canyon and MEG concluded that heavy metal loading was occurring in MEG; however, there was a dramatic reduction in metals concentrations as a result of rerouting the adit drainage from Live Yankee Adit No. 1 around the tailings piles; In combination with ensuring the tailings piles in MEG are not disturbed, there should be no need for further clean-up.
2000-2001	USFS implemented a CERCLA TCRA on the public portions of the tailings piles at the Pacific mine and Dutchman Flat; Barriers were installed at the Pacific, Dutchman Flat and Sultana Smelter to prevent vehicle access to the sites; EPA withdrew participating in removal actions due to federal agency funding restrictions following the 9/11 attacks.
2001	EPA conducted an endangerment assessment on the Pacific mine and Dutchman Flats sites concluded that soil and tailings at these site presented imminent health risks to the public and the environment for exposure to arsenic and lead.
2002	EPA conducted a Removal Assessment at the Yankee mine, Globe mine, Scotchman, and Plume L-94 (a.k.a Silver Wave Adit 1 waste pile). The assessment concluded that elevated concentrations of arsenic, copper, lead, and zinc were present in the tailings, soil, and surface water samples collected from the mines and in MEG; A fish consumption advisory for arsenic was issued by state officials for the North Fork American Fork River and tributaries upstream of Tibble Fork Reservoir which resulted in that segment of the river being listed as 303(d) impaired for arsenic; EPA issues another determination of NFRAP for the CERCLIS site.
2002-2003	USFS abandoned the TCRA and conducted an EE/CA for a non-TCRA; USFS completed a removal of the Dutchman, Wild Dutchman, and Bay State waste rock piles, the Sultana Smelter wastes, Dutchman Mill wastes, and its portion of the Pacific mine

Date	Summary
	tailings which were placed in a repository at the Dutchman Flat site; Oxidizing ponds were developed for the adit drainage at Pacific mine; The waste rock pile at Bog mine was capped in place and the adit drainage from Lower Bog mine diverted into a constructed treatment channel; The CERCLIS site was archived in 2003.
2004-2006	Monitoring and sampling of the adit drainage from the Pacific and Lower Bog mines and American Fork River between 2004 and 2006 showed decreasing efficiency in the passive treatment systems; however, no further treatment of the Lower Bog mine adit drainage was recommended by the USFS, since zinc values in the American Fork River below the confluence with the adit drainage were below State water quality standards; The CERCLIS site was moved to active status in 2005 due to concerns by the USFS about the Pacific Mine.
2006	EPA oversaw a voluntary lead removal action on the private land portion of the Pacific Mine site in 2006 (conducted by Snowbird and Trout Unlimited), including the Pacific mine waste rock pile, the Pacific Mill site, the Blue Rock mine waste rock pile, and the Scotchman No. 2 mine waste rock pile. Wastes were deposited with the waste rock pile at the Pacific mine at what is now the Pacific repository.
2008	Snowbird and Trout Unlimited installed a more permanent drainage system at the Live Yankee Adit No. 1.
2016	Per the CUP, monthly water quality monitoring in MEG has been conducted by Snowbird since April 2016 to identify impacts to water quality due to resort expansion operations. Monthly sampling of dissolved metals will occur for a period of two years to establish a baseline. Quarterly sampling will occur for eight years post construction; The CERCLIS site was moved to the PA ongoing status for the current PA.

2.3.2.1 Tibble Fork Reservoir Dam Rehabilitation Project

The Tibble Fork Reservoir is located in the American Fork Canyon on the American Fork River at the historic site of the Deer Creek terminus (now Tibble Fork Reservoir) and within the historic American Fork mining district (Figure 4). The Tibble Fork Reservoir was built in 1966 for the primary purpose of sediment retention and flood protection with the secondary benefit of recreation (Natural Resource Conservation Service [NRCS], 2015a). Tibble Fork Dam was designed with a total storage of 259 acre-feet (ac-ft) with 175 ac-ft allotted for sediment storage and 84 ac-ft allotted for floodwater storage (NRCS, 2015a). Due to sediment deposition and subsequent sediment removal throughout its 50-year life, the structure currently provides 24 ac-ft of sediment storage and 84 ac-ft of floodwater storage for a total storage capacity of 108 ac-ft (NRCS, 2015a). In an effort to meet current U.S. Department of Agriculture (USDA) NRCS, Utah State Dam Safety regulations, and current engineering standards, the North Utah County Water Conservation District (NUCWCD) began efforts to rehabilitate the dam in June 2016. The purpose was to add an additional 120-180 ac-ft of storage capacity for a total capacity of 175 ac-ft allotted for sediment storage, 85 ac-ft allotted for floodwater storage, and 120 ac-ft allotted for agricultural water management storage (NRCS, 2015a). The dam would also continue to provide flood prevention and sediment retention with the new primary authorized purpose of Agricultural Water Management (NRCS, 2015a). The dam would also continue to provide the secondary benefit of recreation (NRCS, 2015a).

UDEQ – Evaluation of UDEQ Water Quality Data following the Tibble Fork Reservoir Sediment Release (2016) – On August 20, 2016, construction activities during the dam-rehabilitation project unexpectedly released a large quantity of sediment from the reservoir into the North Fork of the American Fork River. This release resulted in a fish kill along a 2-mile stretch of the American Fork River, downstream of the reservoir. The UDEQ evaluated data collected from August 22, 2016 through August 30, 2016 by UDEQ and the Timpanogos Cave National Monument following the sediment release from Tibble Fork Reservoir. UDEQ evaluation of the data is as follows:

- Total and dissolved metals concentrations in water samples collected below the reservoir were 2 to 10 times higher than just upstream of the reservoir (UDEQ, 2016a).
- Based on total metals concentrations in samples collected just three days following the release indicated that the worst conditions in the river occurred between August 20 and August 22, 2016 (UDEQ, 2016a).
- Measurements of water clarity indicated violations of Utah's narrative and numeric water quality standards (UDEQ, 2016a).
- Dissolved metals concentrations in water samples collected on August 22, 2016 below the reservoir did not violate Utah's water quality standards for aquatic life or agricultural uses (UDEQ, 2016a).
- Total metals concentrations in water samples collected between August 22 and August 28, 2016 below the reservoir did not exceed human health values for recreational purposes (UDEQ, 2016a).
- Metals concentrations in sediment samples collected below the reservoir exceeded human health screening values (EPA risk-based Regional Screening Levels [RSLs]) for lead, and exceed aquatic life screening values (EPA Region 3 Freshwater Sediment Screening Benchmarks for Aquatic Life) for arsenic (9.80 mg/kg), cadmium (1.0 mg/kg), copper (31.6 mg/kg), iron, (20,000 mg/kg), lead, (35.8 mg/kg), mercury, (0.2 mg/kg) manganese (460 mg/kg), nickel (22.7 mg/kg), silver (1.0 mg/kg), and zinc (121 mg/kg) (UDEQ, 2016a).
- Metals concentrations in sediment samples collected above Tibble Fork Reservoir on August 23, 2016 also exceeded freshwater aquatic life screening values for arsenic, cadmium, lead, and zinc (UDEQ, 2016a).
- At the request of local city governments, water samples were collected from Highland Glen Reservoir, Heritage Park, and Manila Reservoir on August 31, 2016. These recreation sites are downstream from the canyon and are all fed by irrigation water drawn from American Fork Creek. Analysis of total and dissolved metals in the samples confirmed the levels did not exceed the EPA screening standards for recreational use, agriculture, or aquatic life (UDEQ, 2016a).

UDEQ – Notice of Violation and Compliance Order (NOV/CO) (2016) - On September 28, 2016, the NUCWCD received a NOV/CO for discharging pollutants, degrading water quality beyond state standards, and failing to notify UDEQ (a total of six violations: two for UCA 19-5-107(1)(a), three for Utah Administrative Code [UAC] R317-2, and one for UAC R317-15) (UDEQ, 2016b).

The NOV/CO also cited the NUCWCD for failure to meet U.S. Army Corps of Engineers and Utah DWQ permit conditions (UDEQ, 2016b). The NUCWCD was ordered to come into compliance with the Utah Water Quality Act and the Water Quality rules in the Utah Administrative Code, R317, complete a report evaluating the cause of the release, actions to be taken to obtain compliance with the NOV/CO, and environmental mitigation plans (UDEQ, 2016b). The NOV/CO also required a Monitoring Plan and a Remediation Plan be developed (UDEQ, 2016b).

According to the NOV/CO, the UDWR estimated the total number of rainbow and brown trout killed during the release in the affected portion of the American Fork River was approximately 5,250 (UDEQ, 2016b). On August 22, 2016, surface water samples were collected from the river by NPS employees near Cave Camp Springs in the Timpanogos Cave National Monument. Subsequent analysis of these samples revealed the water contained 7,680 milligram per liter (mg/L) of suspended solids, and 0.276 mg/L arsenic, 5.61 mg/L lead, 0.00427 mg/L mercury, and 8.05 mg/L zinc (UDEQ, 2016b). A water sample taken by NPS employees at the same location on August 8, 2016, contained only 3.60 mg/L of suspended solids, and no detectable concentrations of arsenic, lead, mercury or zinc (UDEQ, 2016b).

On August 23, 2016, the USFS notified the DWQ of the release according to the NOV/CO. The USFS collected water and sediment samples at several locations along the American Fork River. Analysis of these samples indicated the sediment contained concentrations of arsenic, cadmium, lead, and zinc in excess of the EPA Region 3 Freshwater Sediment Screening Values for Aquatic Life (UDEQ, 2016b). The sediment sample taken from the mouth of the canyon also exceeded a human health-based Comparison Value (EPA RSL of 400 mg/kg) for lead (UDEQ, 2016b). Analysis of the water samples also revealed the turbidity of the water exceeded the standards outlined in R317-2-14.1, Numeric Criteria, Standards of Quality for Waters of the State, which prohibit an increase in turbidity of 10 Nephelometric Turbidity Units (NTU) above background levels (UDEQ, 2016b). Turbidity of the water did not return to consistent levels below 10 NTU until September 2 2016, equaling a total of 13 days of violations (UDEQ, 2016b). All sediment samples taken during that timeframe contained arsenic, cadmium, lead, and zinc concentrations in excess of EPA Freshwater Sediment Screening Values for Aquatic Life (UDEQ, 2016b).

<u>DWQ – Settlement (2017)</u> - The discharge resulted in a violation of the Utah Water Quality Act, as amended 1953, as specified in Utah Code Annotated (UCA) 19-5-106(2)(d) (UDEQ, 2017a). The DWQ was delegated authority by the EPA to administer the National Pollutant Discharge Elimination System (NPDES) permit program under the Federal Clean Water Act (CWA) (UDEQ, 2017a). According to the Settlement, NUCWCD must pay a penalty in the amount of $52,500 (civil penalty) and associated costs incurred by the DWQ in the amount of $92,622.55 for a total of $145,122.55 in conformance with the penalty policy outlined in UAC 317-1-8 (UDEQ, 2017a). These costs were for monitoring and labor costs incurred by DWQ between August 23, 2016 and November 4, 2016, and for penalties to resolve the NOV (UDEQ, 2017a). NUCWCD also agreed to fund DWQ approved and UAC R317-1-8 compliant restoration and monitoring projects/plans to return the American Fork River back to pre-incident conditions (UDEQ, 2017a).

<u>NUCWCD – Tibble Fork Dam Sediment Release – Comprehensive Monitoring Plan (2017)</u> – As part of the NOV/CO, NUCWCD was ordered to submit a comprehensive monitoring plan for the

sediment and water in the affected portion of the American Fork River drainage. According to the monitoring plan, water and sediment samples will be collected to determine the overall recovery of the North Fork and the American Fork River (NUCWCD, 2017). Samples will be collected at five locations along the river (including one upstream of Tibble Fork Reservoir) used by DWQ in their post-discharge sampling effort from August 23 through 30, 2016 (NUCWCD, 2017). In addition, downstream sediment deposits and soils potentially irrigated during or shortly after the August 2016 release will be sampled at four downstream locations (Highland Glen Park Reservoir inlet, Manila Park Reservoir inlet, and Lehi and Pleasant Grove ditches) (NUCWCD, 2017). Targeted sampling dates were April 15, 2017 for irrigation ditch water/sediment/soil, August 2017 for river water/sediment/aquatic life, and October/November 2017 for river water/sediment and irrigation ditch sediment/soil (NUCWCD, 2017). Sampling will continue until water and sediment samples meet DWQ numeric criteria for recreational, cold water aquatic wildlife, and agricultural beneficial uses in addition to concentrations at the reference location (upstream of Tibble Fork Reservoir), for one full year (NUCWCD, 2017). Surface water and sediment samples will be analyzed for total and dissolved metals (dissolved metals only for water samples) (NUCWCD, 2017). Irrigation sediment samples will be analyzed for an abbreviated list of total and Toxicity characteristic leaching procedure metals, and low flow (October/November) event samples for arsenic, cadmium, lead, zinc, total dissolved solids, total suspended solids, and turbidity (NUCWCD, 2017). Brief summary reports including samples and field observations will be submitted to DWQ within 30 days of receiving the analytical data following each sampling event (NUCWCD, 2017). In addition, an annual report summarizing sampling activities and laboratory results will be submitted to DWQ (NUCWCD, 2017).

<u>NUCWCD – Technical Memorandum (2017)</u> – As part of the NOV/CO, NUCWCD was ordered to submit a remediation plan for the affected portion of the American Fork River drainage. The plan included cleanup and removal, hauling and disposal, and sampling of sediments from the Highland City Irrigation Basin and the America Fork Irrigation Basin. According to the plan, as of March 16, 2017, a total of approximately 1,748 tons (1,248 cubic yards) had been removed from the two basins and removal form these basins was substantially complete (Jacobs, 2017). The remainder of the sediments from these basins were anticipated to be removed by March 31, 2017 (Jacobs, 2017). A trucking company loaded and transported the material to Intermountain Regional Landfill located at 800 South Allen Ranch Road in Fairfield, UT where it was accepted for disposal based on sediment analytical results (Jacobs, 2017). Sediment was scheduled to be removed from the American Fork Weir and the Cedar Hills Weir the week of March 20, 2017 (Jacobs, 2017). According to the plan, a summary report confirming completion and volume disposed was to be provided to DWQ by April 30, 2017 (Jacobs, 2017).

A total of five grab samples will be collected from the debris basin, each irrigation basin, and the Cedar Hill Weir (one grab sample) in fall 2017. One composite sample was to be collected from the American Fork Weir. All samples were to be analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver (Jacobs, 2017). One sample from each of the Highland City and American Fork Irrigation Basins, and the debris basin will be analyzed for speciated Chromium (chromium-III and chromium-VI) (Jacobs, 2017). Sample results were to be compare to the upstream Tibble Fork Reservoir location (UDEQ Monitoring Location Identification [MLID] 5912840) (Jacobs, 2017). According to the plan, sediments with concentrations close to background could be used as backfill for non-residential public works projects as approved by Utah Division of Waste Management and Radiation Control (Jacobs, 2017). All work was anticipated to be supervised by NUCWCD (Jacobs, 2017).

City of Cedar Hills (2017) – A City Council meeting was held by the City of Cedar Hills on May 2, 2017 with a discussion of the results of the American Fork Canyon water, soil, and sediment testing that was conducted by UDEQ as a result of the sediment release from Tibble Fork in August 2016. A representative with UDEQ-DWQ, discussed results of samples that were collected from the Cedar Hills Golf Course, Mesquite Park, and Heritage Park in the City of Cedar Hills on March 21, 2017. UDEQ's representative indicated that no results were elevated above the screening levels or standards that were used and that it appeared that the samples collected in Cedar Hills were within the standards of natural variation or background levels; if they were elevated, they were still well below what was considered to be excessive for recreational use (City of Cedar Hills, 2017).

As part of the NOV/CO remediation plan, sediment was collected from the irrigation reservoir at the mouth of the canyon and disposed of by NUCWCD. UDEQ's representative indicated that sediments in the riverbed would be allowed to be washed out that spring by runoff and then in late July/August samples would be collected again to determine remaining metals concentrations (City of Cedar Hills, 2017). Sampling would continue until concentrations were back down to background levels; however, results from the fall 2016 sampling event indicated no risks to recreating in the river (City of Cedar Hills, 2017). In addition, as part of the NOV/CO, fish tissue sampling for metals would occur, but the schedule, and whether it included stocking fish or allowing natural reproduction to take effect, were unknown at that time (City of Cedar Hills, 2017).

A timeline summary of previous investigations and regulatory involvement for Tibble Fork Reservoir is provided in the Table 2-3.

Table 2-2 - North Fork/American Fork River and Tibble Fork Reservoir – Timeline of Investigations and Regulatory Actions

Date	Summary
June 2016	In an effort to meet current USDA NRCS, Utah State Dam Safety regulations, and current engineering standards, efforts to rehabilitate the dam began.
August 20, 2016	During efforts to rehabilitate the Tibble Fork Reservoir dam, heavy metals-laden sediment (from abandoned mines upstream of the reservoir) was inadvertently discharged in the American Fork River below the dam.
August 22, 2016 – August 28, 2016	Surface water samples collected from American Fork River exceeded Utah water quality standards for water clarity, but did not exceed aquatic life, agricultural or human health recreational values for metals. Sediment samples collected below the reservoir exceeded human health screening values for lead and exceed aquatic life screening values for arsenic, cadmium, copper, lead, manganese, nickel, and zinc. Metals concentrations in sediment samples collected above Tibble Fork Reservoir also exceed freshwater aquatic life screening values for arsenic, cadmium, lead, and zinc.
September 28, 2016	UDEQ issues a NOV/CO to NUCWCD.
2017-Present	NUCWCD settles with DWQ and submits a remediation plan and monitoring plan to DWQ.

It should be noted that the potential impacts to the American Fork River downstream of the Tibble Fork Reservoir that are being assessed in this PA are based largely on data collected prior to the sediment release from Tibble Fork Reservoir, which is under the jurisdiction of the UDEQ and has a separate process in place to evaluate and remediate conditions resulting from the release.

2.4 CURRENT SITE CONDITIONS

2.4.1 Site Reconnaissance

On August 3 and 4, 2017, a reconnaissance of the area of investigation was conducted by WESTON-EPA START contractor, EPA Site Assessment and Removal Program Managers, Snowbird President and Chief Executive Officer (CEO), Snowbird Director of Water Resources & Environmental Programs, Snowbird's contractor - Salt Lake County Service Area 3, USFS Environmental Engineer, UDEQ DWQ Watershed Protection Section Manager, UDEQ DWQ Environmental Scientist, and UDEQ DERR Environmental Scientist. Collection of in-situ field screening surface water quality measurements were collected by WESTON-EPA START contractor, Snowbird and Salt Lake County Service Area 3 for Snowbird.

Activities conducted during the reconnaissance included:

- A visual inspection of the mine sites visited and surrounding area;
- Photo-documentation of the mine sites visited and surrounding area;
- Collection of Global Positioning System (GPS) coordinates of features and surface water screening locations at the mine sites visited and surrounding areas;
- Collection of water quality field screening parameters (including temperature, pH, oxidation-reduction potential, specific conductivity, dissolved oxygen, and total dissolved solids) from surface water at the mine sites visited and surrounding areas using a hand-held Horiba U-53 water quality meter.

The following section provides a summary of the mine sites visited and surface water screening readings collected. Photographs of site activities, figures of the locations where surface water quality field screening readings were collected, and GPS coordinates are provided in Appendix A.

North Fork American Fork River

Bog Mine

Bog mine and the associated bog area was observed from Mineral Basin Road (Forest Service Road [FSR] 007). Reddish-orange staining was observed on streambed of American Fork River adjacent to the former fen (Appendix A, Photo 17 and Figure 2). Bog Mine Adit 2 (a.k.a. Lower Bog Adit) was collapsed/closed, with an opening approximately 2 feet (ft.) x 2 ft. The adit was observed to be draining at flow rate of approximately 40-50 gallons per minute (gpm). Orange-reddish precipitate was observed on drainage channel which was approximately 4 ft. wide by 8-10 inches deep. (Appendix A, Photos 18 and 19). Beaver damming activity was present in the channel creating pooled areas (Appendix A, Photo 19). Drainage was observed to flow east-southeast of the adit through an excavated channel and outside of original flow path. The complete flow path was not observed during the site reconnaissance.

Water quality field screening measurements including temperature, pH, oxidation-reduction potential, specific conductivity, and dissolved oxygen, and total dissolved solids were collected at one background (BK) location (BMA2-BK) on the North Fork American Fork River upstream and outside of the influence of the Bog Mine Adit 2 drainage (BMA2-AD) and associated waste rock pile. One location (BMA2-APM) downstream of the site and located approximately 125 ft. downstream of MLID 5912050 was collected (Appendix A, Photo 32). Water quality readings collected from the Bog Mine Adit 2 site are presented in Table 2-4.

Table 2-3 - North Fork American Fork and Lower Bog Adit

Location	Temperature (°C)	pH (su)	Oxidation Reduction Potential (mV)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)[1]	Total Dissolved Solids (g/L)
BMA2-BK	11.73	7.22	86	0.160	10.66	101.6	0.104
BMA2-AD	8.72	4.86	178	0.113	3.53	31.3	0.073
BMA2-APM	10.58	7.82	157	0.180	12.91	119.8	0.117

°C = degrees Celsius, su = standard units, m = milli, V = volts, S = Siemens, cm = centimeters, g = grams, L = liters, BMA = Bog Mine Adit, BK = Background, AD = Adit Drainage, APM = Above Pacific Mine

[1] DO readings greater than 100% represent supersaturated water conditions where there is more oxygen in the water than can be used or released to the atmosphere.

A waste rock pile located approximately 75 ft. southeast of the adit was approximately 80 ft. x 70 ft. x 10 ft. (Appendix A, Photo 20). According to Google Earth aerial imagery, the pile is located approximately 15 feet north of the North Fork American Fork.

Silver Dipper Mine Complex

One adit (Silver Dipper Adit 1) and associated waste rock pile coming from the adit opening (Appendix A, Photos 21 and 22, and Figure 2) were observed. The adit was observed to be partially closed/backfilled with the opening approximately 1 foot x 3 ft. x 4 ft. No water was observed draining from the adit; however, an eroded channel with thick willows and vegetation was observed at the adit opening and continuing east across the waste rock pile, indicating flow may occur during early season months. The associated waste rock/tailings pile was approximately 50 ft. x 100 ft. x 10 ft and is located approximately 630 feet upgradient of the North Fork American Fork. Based on a review of Google Earth aerial imagery, there appears to be the potential for the adit to discharge to the North Fork American Fork. No other adits (Silver Dipper Adit 2 and Silver Dipper Adit 3) were observed.

Pacific Mine

The Pacific mine adit was formally closed by the USFS during the 2002-2003 clean-up activities with a pipe draining the adit water at flow rate of approximately 30-40 gpm. The water had a reddish color and precipitate was observed on the drainage channel which was approximately 4 ft. x 10 in. deep (Appendix A, Photos 30 and 31, Figure 3). Drainage was observed to flow northeast of the adit for approximately 250 ft. through an engineered channel to a corrugated drain pipe in Miller Hill Road (FSR 596). A portion of the adit drainage flowed through the pipe, underneath the road, and into the engineered wetland area/ponds. The other portion (approximately half) of the water flowed south down Miller Hill Road (FSR 596) for approximately 150 ft. before flowing east and downslope into the engineered wetland area/ponds (Appendix A, Photo 32).

Water quality field screening measurements were collected at one background location (BMA2-APM) on the American Fork River upstream and outside of the influence of the mine site (Appendix A, Photo 33) and located approximately 125 ft. downstream of MLID 5912050, one location from the Pacific mine adit drainage (PM-AD) (Appendix A, Photos 30 and 31) and one location downstream (DS) of the site (PM-DS) (Appendix A, Photo 34) and Figure 3. Water quality readings collected from the Pacific mine site are presented in Table 2-5.

Table 2-4 - North Fork American Fork and Pacific Mine Adit

Location	Temperature (°C)	pH (su)	Oxidation Reduction Potential (mV)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)[1]	Total Dissolved Solids (g/L)
BMA2-APM	10.58	7.82	157	0.180	12.91	119.8	0.117
PM-AD	6.35	7.00	116	0.292	11.77	98.6	0.190
PM-DS	10.42	8.02	197	0.200	8.22	76.0	0.130

°C = degrees Celsius, su = standard units, m = milli, V = volts, S = Siemens, cm = centimeters, g = grams, L = liters, BMA2 = Bog Mine Adit 2, A = Above, PM = Pacific Mine, AD = Adit Drainage, DS = Downstream

[1] DO readings greater than 100% represent supersaturated water conditions where there is more oxygen in the water than can be used or released to the atmosphere.

Scotchman Adit 1

Former waste rock/tailings pile primarily removed with revegetation/erosion control netting present (Appendix A, Photo 29 and Figure 3). Two small piles totaling approximately 12 cubic yards were observed on the north and south sides of the former pile area. Residual waste material does not appear to be reaching or migrating to the American Fork River. No historic adit or draining water was observed at the site. Heavily utilized camping area with fire ring observed on east side of river across from former waste pile area.

Miller Hill Tunnel

One adit and associated waste rock pile (Appendix A, Photos 23, 24, and 28 and Figure 3) were observed. The adit was observed to be collapsed/closed with wood framing and metal pipes coming out of the adit. Dimensions of the opening could not be determined due to thick vegetation in the adit opening. Water was observed draining from the adit and one of the pipes (approximately 2 inches in diameter) and flowing southeast through thick willows and vegetation, a wetland, and into the North Fork American Fork River (Appendix A, Photo 25) at possibly two locations. Water quality field screening measurements were collected at one background location (MHT-BK) on the American Fork River upstream and outside of the influence of the mine site (Appendix A, Photo 26), from the Miller Hill Tunnel adit drainage (MHT-AD) (Appendix A, Photo 24), and one location downstream of the site (MHT-DS) (Appendix A, Photo 27). Water quality readings collected from the Miller Hill Tunnel site are presented in Table 2-6.

Table 2-5 - North Fork American Fork and Miller Hill Tunnel Adit

Location	Temperature (°C)	pH (su)	Oxidation Reduction Potential (mV)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)[1]	Total Dissolved Solids (g/L)
MHT-BK	8.52	8.18	265	0.202	10.6*	90.9*	0.132
MHT-AD	6.49	7.68	280	0.288	2.68	106.0	0.187
MHT-DS	10.10	8.02	219	0.220	13.51	124.1	0.143

°C = degrees Celsius, su = standard units, m = milli, V = volts, S = Siemens, cm = centimeters, g = grams, L = liters, MHT = Miller Hill Tunnel, BK = Background, AD = Adit Drainage, DS = Downstream, * = Horiba DO probe not working, readings collected from Hilary Arens meter
[1] DO readings greater than 100% represent supersaturated water conditions where there is more oxygen in the water than can be used up or released to the atmosphere.

The associated waste rock pile appeared to be a white limestone and was approximately 170 ft. x 175 ft. x 5 ft. A wetland was observed between the toe of the pile and a spring fed creek (Appendix A, Photo 28). The pile did not appear to come into contact with the spring fed creek or the American Fork River. The spring was located approximately 170 ft. north-northeast of the pile and flowed approximately 300 feet south to the American Fork River.

Mary Ellen Gulch

There are approximately seven mine complexes within MEG with numerous associated features including adits, shafts, prospects and waste piles. Three mine areas were visited during the 2017 site reconnaissance. The mine complexes are shown on Figure 1 and a discussion of the mines visited are presented below from the most upstream to downstream.

Silver Bell Mine Complex

One adit (Silver Bell Adit 1) and associated waste rock/tailings pile coming from adit opening (Appendix A, Photos 1 and 2 and Figure 1) were observed. The adit was observed to be partially closed/backfilled with the opening approximately 20 ft. x 15 ft., depth unknown. No water was observed draining from the adit. The associated tailings pile was approximately 200 ft. x 160 ft. x 5 ft. Eroded channels were noted in the waste pile indicating drainage from the piles into immediate area. Waste material not observed to be reaching the tributary at the headwaters of Mary Ellen Creek. No other adits (Silver Bell Adit 2) were observed to be present.

Globe Mine Complex

Silver Wave Adit 1 and associated waste rock/tailings pile coming from the adit opening were observed (Appendix A, Photos 3 and 4, and Figure 1). The adit was observed to be collapsed and the opening approximately 4 ft. high, width and depth unknown. Wood framing debris and an ore cart rail were observed at the adit opening. No water was observed draining from the adit. The associated waste rock/tailings pile was approximately 125 ft. x 70 ft. x 10 ft. Waste material was not observed to be migrating offsite. An abandoned miners' cabin was located approximately 550 ft. southeast of Silver Wave Adit 1 (Appendix A, Photo 5) with a structurally unsound outhouse located approximately 80 ft. northeast of cabin. Fire pits and shooting targets were observed. The cabin was reported to be potentially utilized by the local Boy Scouts. No other adits (Silver Wave Adit and Silver Wave Adit 2) associated with the Silver Wave area within the Globe mine complex were observed to be present.

Several adits (Appendix A, Photo 6) and waste rock/tailings piles (Appendix A, Photos 7 and 8) were observed associated with the Globe mine portion of the complex. All of the adits were observed to be partially collapsed/backfilled with average opening approximately 1-2 ft. wide by 1 ft. high, depths unknown. None of the adits were observed to be draining water. One small shaft with an approximate opening of 2 ft. x 3 ft., depth unknown, was observed on the north side of Mary Ellen Creek in the Globe mine waste rock/tailings piles and north of a partially collapsed/backfilled adit on the south side of the creek (Appendix A, Photo 7). Mary Ellen Creek (approximately 4 ft. wide by 6 inches deep) was observed to run through and/or adjacent to all of the waste rock/tailings piles present in the Globe Mine Complex (Appendix A, Photos 8 and 9). The approximate dimensions of the piles combined are 900 ft. x 80 ft. x 5 ft. A recreational use road (FSR 011) runs through center of the Globe mine waste rock/tailings piles (Appendix A, Photo 9). The road was closed to vehicular traffic by Snowbird during the 2017 summer season.

Based on a review of Google Earth aerial imagery, Mary Ellen Gulch horizontal closed (HC) 33 and Mary Ellen Gulch HC39 (location names identified by mine inventory/closure activities conducted by DOGM in 1989-1995 [USFS, 2002b]) appeared to potentially have waste piles or drainage associated with them. Therefore, they were visited during the 2016 site reconnaissance and were observed to be naturally occurring red rock and/or soil (Appendix A, Photo 10 and Figure 4). No adits were observed at these locations.

Yankee Mine Complex

Live Yankee Adit 1 and associated waste rock/tailings pile were observed (Appendix A, Photos 11 and 12 and Figure 1). The adit was observed to be closed/backfilled with water draining from a small opening in the backfill. An orange precipitate was observed on the adit drainage channel. The channel was approximately 1-2 ft. x 4 in. The downstream end of a French drain, observed approximately 60 ft. east of the adit, was partially clogged and a portion of the adit drainage flowed through the drain. The adit drainage flowed from the adit approximately 90 ft. east to MEG. The remainder of the adit drainage flowed southeast on the mine road for approximately 120 ft., then flowed east across the waste rock/tailings pile for approximately 100 ft. before entering Mary Ellen Creek. The associated waste rock/tailings pile was approximately 125 ft. x 70 ft. x 10 ft. Mary Ellen Creek runs adjacent to the waste rock/tailings pile at Live Yankee Adit 1. Eroded channels were observed throughout pile.

A second draining adit (Yankee Mine Adit #5) was observed at Yankee mine located approximately 180 ft. south of the Live Yankee Adit 1 (Appendix A, Figure 1). The adit was observed to be closed/backfilled with water draining from a small opening in the backfill and flowing approximately 100 ft. southeast into a pond on the top of the waste rock/tailings pile (Appendix A, Photo 13). Flow from the pond was observed draining out through a vegetated channel on the south side of the pond and downslope into a thickly vegetated area towards Mary Ellen Creek. Orange precipitate was observed on the bottom of the pond. No adit drainage was observed at the Live Yankee Adit 2.

Water quality field screening measurements were collected at a background location on Mary Ellen Creek (MLID 5992274) upstream and outside of the influence of the Globe and Yankee mine sites. Water quality readings collected from Mary Ellen Creek (MLID 5992274), the Live Yankee Adit 1 (MLID 5912310) drainage, and the Yankee Mine Adit #5 (MLID 5912380) drainage from in the pond are presented in Table 2-7.

Table 2-6 - Mary Ellen Gulch, Live Yankee Adit 1, and Yankee Mine Adit#5

Location	Temperature (°C)	pH (su)	Oxidation Reduction Potential (mV)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)[1]	Total Dissolved Solids (g/L)
5992274	6.89	7.74	250	0.116	13.63	115.0	0.075
5912310	6.45	6.27	68	0.158	10.94	92.7	0.103
5912380	15.08	7.05	97	0.323	12.66	130.2	0.210

°C = degrees Celsius, su = standard units, m = milli, V = volts, S = Siemens, cm = centimeters, g = grams, L = liters, LYA = Live Yankee Adit
[1] DO readings greater than 100% represent supersaturated water conditions where there is more oxygen in the water than can be used up or released to the atmosphere.

Mary Ellen Gulch Complex

Mary Ellen Gulch HC2 was observed from Yankee mine and from approximately 175 ft. upslope of the waste rock/tailings pile (Appendix A, Photos 14 and 15 and Figure 1). Two well defined eroded channels from ephemeral water drainage were observed in and adjacent to the waste rock/tailings pile. Waste material was observed migrating downslope from the toe of the pile. The toe of the pile was approximately 150 ft. from East Fork of Mary Ellen Creek. No water was observed draining over pile.

Mary Ellen Gulch HC3 and associated blue waste rock pile coming from the adit opening were observed (Appendix A, Photo 16 and Figure 1). The adit appeared to be closed/backfilled, but the opening dimensions could not be determined. No water was observed draining from the adit.

Field Observations

The American Fork Canyon was observed to be highly utilized for recreational activities including camping, picnicking, hiking, biking, ATV use, fishing, and skiing (in winter months). Evidence of camping (fire pits) was observed on the waste piles at the Silver Dipper Adit 1, Miller Hill Tunnel, and the Miner's Cabin. Evidence of recreational visitors were observed at all of the sites except Bog Mine Adit 2 and Mary Ellen Gulch HC2. None of the waste piles visited were observed to be contained or inaccessible with the exception of Bog Mine Adit 1 and Pacific mine, which were capped and revegetated during historic clean-up activities. The mine sites in general are accessible to any persons; however, the mine sites that were visited are located on private property (owned by Snowbird), with the exception of Bog and Mary Ellen Gulch HC2 mine sites. Access to the sites and other areas visited during this portion of the investigation requires hiking, ATVs or high-clearance four-wheel drive vehicles to navigate the muddy or rutted and rocky roads. Access is made increasingly difficult with precipitation events.

No evidence of stressed vegetation as a result of mining activities or waste material was observed near the sites or any locations visited downstream of the sites. START observed moose, deer and cat scat, and a mule deer. START also spoke with a young adult male that was fishing on the American Fork River just upstream of the Scotchman Adit 1 who reported that he was catching small brown trout and that he did not eat what he caught; he was releasing them back into the river.

3.0 DATA USEABILITY AND REVIEW OF EXISTING ANALYTICAL DATA

3.1 REVIEW OF SECONDARY DATA

Secondary data involves the gathering and/or use of existing environmental data for purposes other than those for which they were originally collected. The quality of secondary data were evaluated to ensure they are of the type and quality necessary to support their intended uses. When evaluating the reliability of secondary data and determining limitations on their uses, consideration was given to the source of the data, the time period during which it was collected, data collection methods, potential sources of uncertainty, and the type of supporting documentation available. With respect to secondary analytical data that will be utilized to support critical decisions, such as comparison of contaminant levels with applicable standards, a detailed review of the data was conducted to determine the usability of the data. In addition to the qualitative rating of the data source, a data quality review and documentation of the review were completed in the data usability summary below.

In accordance with EPA guidance documents "A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information" (June 2003) and subsequent addendum "Guidance for Evaluating and Documenting the Quality of Existing Scientific and Technical Information" (December 2012), the following assessment factors were utilized to assess the quality and relevance of scientific and technical information:

1. **Soundness** – the extent to which the scientific and technical procedures, measures, methods or models employed to generate the information are reasonable for, and consistent with, the intended application.
2. **Applicability and Utility** – the extent to which the information is relevant for the EPA's intended use to meet observed release criteria or to assess historical trends in the AF Canyon.
3. **Clarity and Completeness** – the degree of clarity and completeness with which the data, assumptions, methods, quality assurance, sponsoring organizations and analyses employed to generate the information are documented.
4. **Uncertainty and Variability** – the extent to which the variability and uncertainty (quantitative and qualitative) in the information or in the procedures, measures, methods or models are evaluated and characterized.
5. **Evaluation and Review** – the extent of independent verification, validation and peer review of the information or of the procedures, measures, methods or models.

The type of information, sources of information and quantity of information are site-specific. Analytical data from groundwater, surface water, sediment, and soil were collected within the study area by Snowbird, EPA, USFS, NPS, UDEQ, and their contractors from 1980 through present. Tables presented in Sections 3.3 through 3.6 present the assessment of the Secondary Data obtained and reviewed for this PA. Assessment factors were rated as Acceptable, Marginal, Unacceptable, Not Applicable, or Indeterminate, in accordance with the EPA guidance.

3.2 SCREEENING BENCHMARKS AND COMPARISONS

Data were compiled and used to compare to relevant benchmarks. It should be noted that the benchmarks are used as a conservative screening tool and exceedances of these benchmarks do not automatically indicate a risk or that a response action is warranted, but may indicate additional data or evaluation is needed. There are different types of available benchmarks that are used to assess analytical results and they provide a relative understanding of the condition at the site. Analytical results were compiled and evaluated using several different types of benchmarks in order to:

- Document if a contaminant release has occurred as defined by the HRS criteria and CERCLA;
- Assess the potential for risk to human health and the environment.

Screening benchmarks are described in the following subsections.

3.2.1 HRS Benchmarks

- Comparison to Three Times mine site-specific Background Results
- Superfund Chemical Data Matrix (SCDM) Hazardous Substance Benchmarks, Surface Water Pathway – Environmental and Drinking Water (EPA, 2014)

Data were evaluated for use in documenting an Observed Release using HRS criteria for each pathway (i.e., groundwater, surface water, soil and air), as applicable, in accordance with EPA guidance for "Establishing an Observed Release" (September 1995). An Observed Release is based on evidence that contaminants have migrated from a site through a pathway or medium (EPA, 1995b). The HRS establishes two general criteria to document an observed release: 1) there must be evidence of a hazardous substance in the medium of concern at a concentration significantly (three times) above the mine site-specific background level, and 2) the release of the hazardous substance must be at least partially attributable to the site under investigation (Hazard Ranking System, Final Rule, 40 Code of Federal Regulations (CFR) Part 300, App. A) (EPA, 1995b). An observed release can be determined either by chemical analysis of samples, or by directly observing the release of the hazardous substance (to be documented) into the medium of concern (EPA, 1995b). Observed releases can occur through the groundwater, surface water, and air migration pathways (EPA, 1995b). In contrast, the soil exposure pathway is evaluated for observed contamination where targets (human populations, resources, and sensitive environments) may come into direct contact with contaminants (EPA, 1995b).

Documenting an Observed Release is a prerequisite for evaluating actual contamination at human and environmental targets, which indicates a high likelihood of exposure to hazardous substances (EPA, 1995b). The level of actual contamination is determined by comparing concentrations in release samples (for example a surface water sample downstream of a source of contamination) to SCDM health-based or environmental benchmark values, where available (EPA, 1995b). SCDMs were not used in the assessment of groundwater and soil samples as there are no targets identified for comparison to these HRS criteria for these migration pathways.

Per EPA "Guidance for Performing Site Inspections Under CERCLA" (EPA, 1992a), background data were compared against mine site-specific analytical results. Surface water sample locations were compared to downstream samples in order to assess metals concentrations that could be attributed to mine adit drainages and/or waste piles. Background sample locations were selected from upstream of each mine site (potential source) and presumably outside of the influence of any other mining activities associated with each mine site.

As required by EPA HRS guidance, the three times background concentration was calculated for each analyte using the detected laboratory result for surface water background samples. An Observed Release is documented when a hazardous substance is detected at a concentration equal to or greater than three times the detected background concentration and is attributable to the site. If a background concentration is not detected, then an Observed Release (termed "Observed Contamination" for the soil exposure pathway) is documented when the sample concentration equals or exceeds the sample quantitation limit of the background sample (EPA, 1995b).

3.2.2 Human Health and Environment Screening Criteria

The human health and environment evaluation involved comparison to relevant benchmarks or standards, where available.

Groundwater

- UAC Rule R309-200. Monitoring and Water Quality: Drinking Water Standards (Utah Office of Administrative Rules [UOAR], 2014)
- UAC Rule R317-6. Ground Water Quality Protection (UOAR, 2017a)
- EPA Maximum Contaminant Level (MCL) (November, 2017)

Surface Water

- UAC Rule R317-2. Standards of Quality for Waters of the State (UOAR, 2017b)

Surface water samples were compared to numeric criteria for aquatic wildlife and agricultural uses in UAC Rule R317-2 Standards of Quality for Waters of the State (June 2017) for Classes 2B, 3A, and 4 waters as assigned to the North Fork/American Fork River and its tributaries by the State (UOAR, 2017). The classes are protective of recreation including, but not limited to, wading, hunting, and fishing, cold water species of game fish and other cold water aquatic life, and agricultural uses including irrigation of crops and stock watering (UOAR, 2017). These criteria were compared to dissolved sample concentrations for select metals for which the State has developed criteria, and include aluminum, arsenic, cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc. Of these metals, cadmium, copper, lead, nickel, silver, and zinc are hardness-dependent criteria which require calculations of the standard based on sample specific hardness values. As such, the following equations Table 3-1 were used.

Table 3-1 - Equations to Convert Total Recoverable Metals Standard with Hardness Dependence to Dissolved Metals Standard by Application of a Conversion Factor

Metal	1-Hour Average (Acute) (µg/L)	4-Day Average (Chronic) (µg/L)
Cadmium	CF * e (1.0166(ln(hardness))-3.924) CF = 1.136672 - ln(hardness)(0.041838)	CF * e (0.7409 (ln(hardness)) -4.719 CF = 1.101672 - ln(hardness) (0.041838)
Copper	CF * e(0.9422(ln(hardness))- 1.700) CF = 0.960	CF * e(0.8545(ln(hardness)) -1.702) CF = 0.960
Lead	CF * e(1.273(ln(hardness))-1.460) CF = 1.46203 - ln(hardness)(0.145712)	CF * e(1.273(ln(hardness))-4.705) CF = 1.46203 - ln(hardness)(0.145712)
Nickel	CF * e(0.8460(ln(hardness)) +2.255) CF= 0.998	CF * e(0.8460(ln(hardness))+0.0584) CF = 0.997
Silver	CF * e(1.72(ln(hardness))- 6.59) CF = 0.85	Not Applicable
Zinc	CF * e(0.8473(ln(hardness)) +0.884) CF = 0.978	CF * e(0.8473(ln(hardness))+0.884) CF = 0.986

Notes:
CF – Conversion Factor
ln – natural logarithm
µg/L – micrograms per liter
mg/L – milligrams per liter
Hardness as mg/l $CaCO_3$.

<u>Sediment</u>

- EPA Region III Biological Technical Assistance Group (BTAG) - Freshwater Sediment Screening Benchmarks, August 2006 (EPA, 2006), which are based on Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al., 2000)
- Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines (Ingersoll, et al., 2000)

  NOTE: The sediment benchmarks were derived by review and compilation of available sediment toxicity studies found in peer-reviewed ecotoxicological literature related to a variety of benthic macroinvertebrate species and determined to meet quality control criteria related to the study design and performance. The studies used to derive the benchmarks are from a pool of sites located in various parts of the country in different types of sediment. Thus, the effects that occurred in the studies and reflected in the benchmarks may not necessarily represent potential for effects in AF Canyon.

<u>Soil</u>

- EPA Regional Screening Levels (RSLs), Residential and Industrial Soils (EPA, 2017a)

Soil samples were compared to EPA Residential and Industrial Soil RSLs. The EPA RSLs are included to provide comparison to the most conservative (i.e., most protective) risk-based benchmarks and to provide a baseline level of comparative risk. The primary use of the risk-based benchmarks is to identify analytes that are detected at concentrations that are below these conservative benchmarks, thus, the analytes detected below these benchmarks can safely be eliminated from further assessment and the evaluation can focus on other analytes that may be of concern. Analytes that are detected above a screening benchmark do not necessarily indicate a risk, but rather that additional evaluation may be needed.

3.3 GROUNDWATER DATA

Groundwater samples collected in the AF Canyon in 1998 and 2016 were compared to Utah Division of Administrative Rules (DAR) R309-200-5 standards for drinking water, where applicable. These standards are for protection of public drinking water systems and were compared to samples collected from such systems within the AF Canyon. Groundwater samples collected from monitoring wells in 2001 were compared to DAR R317-6 and EPA MCLs, which are established for the protection of groundwater. Groundwater samples were used to document potential contamination of potable water supplies within the AF Canyon. Groundwater data and the benchmarks used in this evaluation are provided in Table 5. Groundwater data reviewed are presented in Table 3-2.

Table 3-2 - Groundwater Data Reviewed

Data Collected by/ Obtained From and Purpose	Sample Date(s)	Analysis	Data Quality	Data Usability	Data Used in PA	Benchmarks
DWQ/DWQ Presumed to be collected to document possible metals contamination	7/25/01	Dissolved Metals, Hardness, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)	Acceptable	Acceptable	No – Locations potentially representative of groundwater conditions outside the area of influence of the mine sites, but no downgradient samples available for comparison	Utah DAR R317-6 (November 1, 2017), EPA MCL (November, 2017)
USFS/DWQ Presumed to be collected to document possible metals contamination	1998	Metals	Acceptable	Acceptable	To determine metals concentrations in groundwater	Utah DAR R309-200-5 (May 23, 2014)
American Fork City/DWQ Collected in response to sediment release from Tibble Fork Reservoir	2016	Metals	Acceptable	Acceptable	To determine metals contamination in potable drinking water sources	Utah DAR R309-200-5 (May 1, 2016)

3.4 SURFACE WATER DATA

Surface water samples collected in the AF Canyon were compared to EPA SCDM Acute Criteria Maximum Concentration (CMC) and Chronic Criteria Continuous Concentration (CCC) aquatic life screening values. The SCDM screening concentration benchmarks are applied when evaluating potential NPL sites using the HRS (40 CFR Part 300 Appendix A, 55 FSR 51583). The SCDM surface water screening concentration benchmarks are environmental pathway limits used for quickly assessing sites at the screening stage. An exceedance of these values does not necessarily indicate that adverse health effects will occur; rather, it indicates that further evaluation is warranted. Also utilized were UAC Rule R317-2 Standards of Quality for Waters of the State (WQS) 1-Hour Average (acute), 4-Day Average (chronic), and Agriculture ecological standards (EPA, 2014; UOAR, 2017) which are intended to be protective of the watershed's beneficial uses. Surface water release samples collected from the North Fork American Fork River and Mary Ellen Creek were compared to the three times background concentration to meet Observed Release criteria as defined by CERCLA (EPA, 1992a; EPA, 1995b). Surface water data and the benchmarks used in evaluation of surface water are provided on Tables 3a and 3b (to document metals present in source material), and7a to 10b, 12a, and 12b. Surface water data reviewed are provided in Table 3-3.

Table 3-3 - Surface Water Data Reviewed

Data Collected by/ Obtained From and Purpose	Sample Date(s)	Analysis	Data Quality	Data Usability	Data Used in PA	Benchmarks
DWQ/DWQ Collected for water quality assessments	1981, 1991-1997, and 1999	Dissolved Metals, Hardness, TSS, TDS, Turbidity, Carbonate, Calcium Carbonate	Acceptable	Data are useable for the purposes of this PA	No – More recent sampling data used	NA
USGS Collected for mass loading studies	American Fork 1999, MEG 2000	Dissolved Metals, Alkalinity, Sulfate, Chloride, Silica, pH, Discharge	Acceptable	Data are useable for the purposes of this PA	No – More recent sampling data used	NA
DWQ/DWQ Collected for monitoring	2000	Dissolved Metals	Acceptable	Data are useable for the purposes of this PA	To summarize historic metals concentrations in the American Fork River	EPA SCDMs, R317-2-14
USFS/USFS Collected for water quality assessments	Biannually from 2004-2007	Dissolved Metals, Hardness, Cations, Anions, Nutrients (as N), TSS, Turbidity, Carbonate, Bicarbonate, Conductivity, Alkalinity, pH	Acceptable	Data are useable for the purposes of this PA	To document historic metals concentrations in sources and in the American Fork River above the confluence with MEG	EPA SCDMs, R317-2-14
DWQ/DWQ Collected for water quality assessments	10/23/2008	Dissolved Metals, TDS, TSS,	Acceptable	Data are useable for	To document metals concentrations in release samples in North Fork	EPA SCDMs, R317-2-14

Data Collected by/ Obtained From and Purpose	Sample Date(s)	Analysis	Data Quality	Data Usability	Data Used in PA	Benchmarks
		Acidity, Calcium carbonate, Carbonate, Hardness, Turbidity, Flow		the purposes of this PA	American Fork to meet Observed Release criteria for Pacific Mine	
DWQ/DWQ Reason for sample collection unknown	10/26/2011	Dissolved Metals, TDS, TSS, Acidity, Calcium carbonate, Carbonate, Hardness, Turbidity, Flow	Acceptable	Data are useable for the purposes of this PA	To summarize historic metals concentrations in the American Fork River	R317-2-14
NPS/NPS Collected in response to sediment release from Tibble Fork Reservoir	8/9/16	Select Total Metals, TDS, TSS, Acidity, Carbonate, Bicarbonate, Chloride, Nitrate/Nitrite, Sulfate	Acceptable	Data are useable for the purposes of this PA	No – Data run for select total metals. No applicable samples or benchmarks for comparison	NA
NPS/NPS Collected in response to sediment release from Tibble Fork Reservoir	8/22/16	Total Metals, TDS, TSS, Acidity, Carbonate, Bicarbonate, Chloride, Nitrate/Nitrite, Sulfate	Acceptable	Data are useable for the purposes of this PA	No – Data collected post sediment release from Tibble Fork Reservoir	NA
NPS+DWQ/UDEQ Tibble Release 2016 Collected in response to sediment release from Tibble Fork Reservoir	August 22-28, 30, 31, and September 1, 3, 5, and 6, 2016	Total and Dissolved Target Analyte List (TAL) Metals, TDS, TSS, Acidity, Carbonate, Bicarbonate, Chloride, Nitrate/Nitrite, Sulfate	Acceptable	Data are useable for the purposes of this PA	No – Data collected post sediment release from Tibble Fork Reservoir and no comparative upstream samples	R317-2-14
Snowbird/DWQ Collected for monthly monitoring	Monthly from 4/2016-6/2017	Dissolved Metals, Hardness, TDS, pH	Acceptable	Data are useable for the purposes of this PA	To document metals concentrations in source and release samples in MEG to meet Observed Release criteria	EPA SCDMs, R317-2-14

3.5 SEDIMENT DATA

Sediment samples collected in the AF Canyon were compared to freshwater aquatic life sediment screening benchmarks from EPA Region III BTAG Freshwater Sediment Screening Values which are the Threshold Effect Levels (TECs) (EPA, 2006) derived in "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" (MacDonald and Ingersoll, et.al, 2000). Probable Effect Concentration (PEC) sediment benchmarks as derived in "Prediction of Sediment Toxicity Using Consensus-Based Freshwater Sediment Quality Guidelines" (Ingersoll et al., 2000) are also used in this report. Sediment data and the benchmarks used in this evaluation are provided on Tables 13a and 13b. Sediment data reviewed are presented in Table 3-4.

Table 3-4 - Sediment Data Reviewed

Data Source	Sample Date(s)	Analysis	Data Quality	Data Usability	Data Used in PA	Benchmarks
NRCS Watershed Plan No. 10 2015 Collected as part of a sediment survey	2010	Total Metals	Acceptable	Data are useable for the purposes of this PA	To document historic metals concentrations in Tibble Fork Reservoir	EPA Region III BTAG Freshwater Sediment Benchmarks, 2006 Consensus-Based Probable Effect Concentrations, EPA 2000
UDEQ Tibble Release 2016 Collected in response to sediment release from Tibble Fork Reservoir	August 23, 27,-28, and September 1, 2016	Total Metals	Acceptable	Data are useable for the purposes of this PA	To document recent metals concentrations in American Fork River just above Tibble Fork Reservoir to the mouth of the canyon	EPA Region III BTAG Freshwater Sediment Benchmarks, 2006 Consensus-Based Probable Effect Concentrations, EPA 2000

3.6 SOIL DATA

Soil and waste samples and XRF readings were collected from Pacific Mill and the Yankee mine sites and results compared to the EPA Residential and Industrial RSLs. The EPA RSLs are based on potential exposure scenarios which assume 1) there are residential properties and uses associated with people living directly at the mine sites; or 2) there are industrial exposures associated with working in the mine area, such as construction or a clean-up action (e.g., digging in soils) (respectively). It is recognized that these scenarios are not necessarily present at the mine sites, so comparisons to the RSLs are for relative information and initial screening purposes only.

The RSLs are generic screening levels based on default exposure parameters and factors that are considered to represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's "Soil Screening Guidance for Superfund Sites" (EPA, 2002). Soil data and the benchmarks used in this evaluation are provided on Tables 4b and 14. Soil data reviewed are presented in Table 3-5.

Table 3-5 - Soil Data Reviewed

Data Source	Sample Dates	Analysis	Data Quality	Data Usability	Data Used in PA	Benchmarks
Trout Unlimited EE/CA 2004	2000	XRF Metals	Acceptable	Data are useable for the purposes of this PA	No – Results prior to 2006 clean-up activities	NA
EPA PA 2002	2001	XRF Metals and TAL Metals	Acceptable	Data are useable for the purposes of this PA	To document metals concentrations in sources to meet Observed Release criteria	EPA Residential and Industrial RSLs
SAIC Watershed Restoration Evaluation 2001	2001	XRF Metals	Acceptable	Data are useable for the purposes of this PA	To document metals concentrations in sources to meet Observed Release criteria	EPA Residential and Industrial RSLs

4.0 SOURCES OF CONTAMINATION AND WASTE CHARACTERISTICS

As described in the EPA "Guidance for Performing Preliminary Assessments under CERCLA" (EPA, 1991), a contaminant source is defined as an area where a hazardous substance may have been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance. In general, however, the volumes of air, groundwater, surface water, and surface water sediments that may have become contaminated through migration are not considered sources (EPA, 1992b). Known and potential sources in the AF Canyon include heavy metals contaminated soils, waste rock, tailings, and groundwater discharging from mine adits and expressed as surface water drainage associated with former mining and milling processes. Heavy metals are present across the mine sites and migration of these offsite into nearby surface water bodies has been documented in either historic and/or recent sampling. Adit drainages and surface soil/waste samples from the waste piles have contained significantly elevated concentrations of heavy metals (Tables 3a through 4b). There may be other sources present within the AF Canyon that have not been sampled and/or evaluated in this PA.

The aforementioned samples are used to document metals in source surface water and waste material/soil samples as required by the HRS. HRS evaluation merely documents presence/absence of a hazardous substance in an environmental media (source samples) in order to affirm contribution of that contaminant from a specific source to the surrounding environment (release samples). HRS source samples evaluated in this PA are presented in Tables 3a and 4a, while source samples evaluated for human health and the environment and presented in Tables 3b and 4b.

4.1 ADIT DRAINAGES

4.1.1 Sample locations

In the North Fork American River, the most recent samples collected from the Lower Bog (MD-LBAD) and Pacific (MD-PMAD) mine adit drainages in North Fork of American Fork being evaluated in this PA were collected by the USFS in September 2007. The results from the sample collected in September 2007 was sufficient to document all of the contaminants of potential concern (COPCs) as identified in the review of historical data (Section 2.3.2). Sample locations are described in Table 2 and shown on Figure 7a.

In MEG, the most recent samples collected from Live Yankee Adit No. 1 (a.k.a Yankee Adit #4) (5912310) and Yankee Mine Adit #1 (5912280) being evaluated in this PA were collected from the adit drainage monthly sampling conducted by Snowbird in 2016 and in September 2000 by UDEQ, respectively. Sample locations are described in Table 2 and shown on Figure 7b.

4.1.2 North Fork American Fork River Analytical Results Summary

Sample MD-LBAD was collected from the Lower Bog adit (Figure 7a). Recent adit analytical results are summarized in Table 3b.

Concentrations of dissolved aluminum, cadmium, copper, iron, lead, nickel and zinc were detected in sample MD-LBAD. Of these, concentrations of dissolved cadmium, copper, iron, and zinc exceeded one or both Utah Aquatic Wildlife WQS and the 4-Day Average for lead. Results for cadmium (10 µg/L) significantly exceeded the Utah WQS 1-Hour (0.8 µg/L) and Utah WQS 4-Day (0.1 µg/L). The concentration of zinc was 490 µg/L, which exceeded both Utah WQS. No other analytes were detected at concentrations exceeding any Utah WQS.

Concentrations of dissolved cadmium, copper, nickel and zinc were detected in the sample collected from the Pacific mine adit (MD-PMAD). Of these, concentrations of dissolved cadmium and zinc exceeded both Utah Aquatic Wildlife WQS. Results for cadmium (8.2 µg/L) significantly exceeded the Utah WQS 1-Hour (3.9 µg/L) and WQS 4-Day (0.4 µg/L). The concentration of zinc (1100 µg/L) also significantly exceeded both Utah WQS. No other analytes were detected at concentrations exceeding any Utah WQS.

4.1.3 Mary Ellen Gulch Analytical Results Summary

Sample 5912310 was collected from the Live Yankee Adit No. 1 in MEG (Figure 7b). Recent adit analytical results are summarized in Table 3b.

Concentrations of dissolved arsenic, cadmium, copper, iron, lead, nickel and zinc were detected in the samples collected. Of these, concentrations of dissolved cadmium, iron, and zinc exceeded one or both Utah Aquatic Wildlife WQS. Results for cadmium ranged from 0.2 U µg/L (October through December 2016 samples) to 4 µg/L (May) with more than half of the results significantly exceeding the 4-Day WQS. Only the sample collected in May (4 µg/L) had a concentration that also exceeded the 1-Hour WQS (2.4 µg/L). Concentrations of iron ranged from 70 µg/L (June and October) to 2,230 µg/L (August) with approximately half of the samples exceeding the 1-Hour WQS (1,000 µg/L). Concentrations of zinc ranged from 260 µg/L (October) 880 µg/L (May) and with all samples exceeding both the 1-Hour and 4-Day WQS. No other analytes were detected at concentrations exceeding any Utah WQS.

Sample 5912280 was collected from the Yankee Mine Adit # 1 in MEG (Figure 7b). Adit analytical results from 2000 are summarized in Tables 3a and 3b.

These results indicate that concentrations of dissolved iron were detected at 4,800 µg/L which exceeded the 1-Hour WQS (1000 µg/L). Dissolved zinc was detected at 361 µg/L which significantly exceeded both the 1-Hour and 4-Day WQS. No other analytes were detected at concentrations exceeding any Utah WQS.

4.2 WASTE PILES

4.2.1 Sample Locations

As discussed in Section 2.3.2, the USBR conducted soil, waste rock and tailings XRF screening in North Fork American Fork Canyon at the Miller Hill Tunnel and Lower Bog mine in June and October 2000. A total of 10 XRF waste rock samples were collected from nine waste rock piles for XRF analysis of antimony, arsenic, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc. These sampled areas meet the definition of “pile” described in HRS

Table 2-5, indicating they could also be evaluated as potential sources of contamination for HRS scoring purposes (EPA, 1990). XRF sample locations were not reported by the contractor conducting the work (SAIC, 2001).

The EPA conducted soil/waste material sampling in MEG at the Live Yankee and Globe mines in October 2001. A total of 25 surface soil samples (including 3 duplicates) were collected from 0-4 inches below ground surface (bgs). Sample locations are described in Table 2 and shown on Figure 9.

4.2.2 North Fork American Fork Canyon Analytical Results Summary

Lower Bog Mine

A total of four waste rock samples were collected and screened with an XRF from the Lower Bog mine pile. The majority of the samples collected from the waste rock pile had concentrations of lead, silver, and zinc (SAIC, 2001). Screening results of the maximum concentrations as reported by SAIC are summarized in Table 4b.

Lead (576 mg/kg) and silver (1,240 mg/kg) maximum concentrations reported by SAIC exceeded only the EPA Residential RSLs of 400 mg/kg and 390 mg/kg, respectively.

Miller Hill Tunnel

A total of six waste rock samples were collected and screened with an XRF from the Miller Hill Tunnel pile. The majority of the samples collected from the waste rock pile had concentrations of arsenic, lead, and zinc (SAIC, 2001). Screening results of the maximum concentrations as reported by SAIC are summarized in Table 4b.

Only concentrations of arsenic (only maximum concentration of 60 mg/kg reported) significantly exceeded the both the EPA Residential (0.68 mg/kg) and Industrial (3 mg/kg) RSLs. Lead, manganese, and zinc were also detected, but the maximum concentrations reported did not exceed the corresponding EPA RLSs.

4.2.3 Mary Ellen Gulch Analytical Results Summary

Yankee Mine

Soil/tailings samples 2 through 86 (except samples 14, 59, 61, 64, 75, and 86) were collected from the Yankee mine tailings piles and downgradient adjacent areas in MEG in 2001 (Figure 9). Sample locations were estimated based on the figures and sample descriptions provided in the "Final Report, Yankee Mine Site, Utah County, Utah, August 2002" (Lockheed Martin/REAC, 2002). Soil/tailings analytical results are summarized in Tables 4a and 4b.

Concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, thallium, and zinc exceeded one or both EPA Soil RSLs in the samples collected from the tailings piles. The majority of the samples collected had concentrations of arsenic and lead that significantly exceeded both the EPA Residential and Industrial RSLs. Table 4-1 is a summary by contaminant of the highest detected analytical results among the source samples collected from the Yankee mine.

Table 4-1 - Yankee Mine Soil/Tailings Analytical Results Exceedances

Analyte	Min (mg/kg)	Max (mg/kg)	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Sample ID with Highest Concentration
Antimony	5.8 U	1,900	31	470	28
Arsenic	43	1,200	0.68	3	35
Cadmium	1.1	470	71	980	29
Copper	50	15,000	3,100	47,000	20
Iron	7,900	130,000	55,000	820,000	18
Lead	86	32,000	400	800	28
Mercury	0.26	67	11	46	29
Thallium	2.4 U	4.6	0.78	12	4
Zinc	160	59,000	23,000	350,000	29

Globe Mine

Soil/tailings samples 59, 61, 64, and 75 were collected from the Globe mine tailings piles in MEG (Figure 9). Soil/tailings analytical results are summarized in Tables 4a and 4b.

Concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, thallium, and zinc exceeded one or more human health screening benchmark in the samples collected from the tailings piles. At least half of the samples collected from the tailings piles had concentrations of antimony, arsenic, and iron that significantly exceeded both the EPA Residential and Industrial RSLs. Table 4-2 is a summary by contaminant of the highest detected analytical results among the source samples collected from Globe mine.

Table 4-2 - Globe Mine Soil/Tailings Analytical Results Exceedances

Analyte	Min (mg/kg)	Max (mg/kg)	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Sample ID with Highest Concentration
Antimony	5.8 U	2,800	31	470	61
Arsenic	160	560	0.68	3	61
Cadmium	1.4	220	71	980	61
Copper	36	3,600	3,100	47,000	64
Iron	23,000	61,000	55,000	820,000	75
Lead	95	95,000	400	800	61
Mercury	0.15	32	11	46	64
Thallium	0.93 U	1.1	0.78	12	59
Zinc	190	29,000	23,000	350,000	61

4.2.4 Conclusions

Based on the sources of known or suspected hazardous waste, historic investigation area uses, and observations and pH readings collected during the site reconnaissance activities previously described, the associated COPCs in the AF Canyon are acid mine drainage and heavy metals (aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, mercury, nickel, thallium, and zinc). These COPCs and their associated sources are shown in Table 4-3.

Table 4-3 - American Fork Canyon - Potential Mining Sources

Source	COPCs	Citation	Waste Features	Citation
North Fork American Fork River				
Lower Bog Mine Adit Drainage	Cadmium, copper, iron, lead, and zinc	Lidstone & Anderson, 1993	pH of 5.1, discharge rate of approximately 44 gpm	Lidstone & Anderson, 1993
			pH of 4.86, discharge rate of approximately 40-50 gpm	Observed during August 2017 site reconnaissance
Lower Bog Mine Tailings Pile	Lead, silver, and zinc	SAIC, 2001	Approximately 69,000 cubic feet	Lidstone & Anderson, 1993
Pacific Mine Adit Drainage	Cadmium, copper, lead, and zinc	Lidstone & Anderson, 1993	pH of 5.1, discharge rate of approximately 44 gpm	Lidstone & Anderson, 1993
			pH of 7.0, discharge rate of approximately 30-40 gpm observed during August 2017 site reconnaissance.	Observed during August 2017 site reconnaissance
Miller Hill Tunnel HC10 Waste Rock Pile	Arsenic, lead, manganese, and zinc	SAIC, 2001	Approximately 97,000 cubic feet. Located approximately 40 ft. from spring fed creek and American Fork River	Observed during August 2017 site reconnaissance
Mary Ellen Gulch				
MEG HC2 Waste Rock/Tailings Pile	Heavy metals (presumed based on mining history and area geology)	NA	Approximately 22,500 cubic feet. Located approximately 140 ft. from spring fed east tributary to Mary Ellen Creek.	Observed during August 2017 site reconnaissance
Globe Mine Tailings Piles	Arsenic, copper, lead, mercury, and zinc	Lockheed Martin/REAC, 2002	Approximately 278,320 cubic feet. Located adjacent to Mary Ellen Creek.	Observed during August 2017 site reconnaissance
	Antimony, cadmium, iron, thallium, and zinc	Current PA, Table 5b		
Yankee Mine Adit #1 (MLID 5912280) Drainage	Arsenic, iron, and zinc	Current PA, Table 4b	Discharge rate between 0.3 cubic feet per second (cfs) and 0.4 cfs	UDEQ, 2017c

<table>
<tr><th>Source</th><th>COPCs</th><th>Citation</th><th>Waste Features</th><th>Citation</th></tr>
<tr><td rowspan="4">Live Yankee Adit No. 1 (a.k.a Yankee Mine Adit #4) Drainage (MLID 5912310)</td><td rowspan="3">Aluminum, antimony, arsenic, barium, manganese, nickel</td><td rowspan="3">Lockheed Martin/REAC, 2002</td><td>pH of 5.95, discharge rate of approximately 70 gpm</td><td>Lidstone & Anderson, 1993</td></tr>
<tr><td>pH of 6.72 and greater than 5 gpm</td><td>Lockheed Martin/REAC, 2002</td></tr>
<tr><td rowspan="2">pH 6.27 and half of drainage observed flowing over tailings piles into Mary Ellen Creek</td><td rowspan="2">Observed during August 2017 site reconnaissance</td></tr>
<tr><td>Cadmium, copper, iron, lead, and zinc</td><td>Current PA, Table 5b</td></tr>
<tr><td rowspan="2">Yankee Mines Tailings Piles</td><td>Arsenic, copper, lead, mercury, and zinc</td><td>Lockheed Martin/REAC, 2002</td><td rowspan="2">Approximately 1,553,450 cubic feet. Located adjacent to Mary Ellen Creek.</td><td rowspan="2">Observed during August 2017 site reconnaissance and using Google Earth imagery</td></tr>
<tr><td>Antimony, cadmium, iron, thallium, and zinc</td><td>Current PA, Table 5b</td></tr>
</table>

5.0 PATHWAY ANALYSIS

The following sections describe and discuss the physical conditions, migration pathway targets, releases or potential releases. A CERCLA Authority Checklist (Appendix C) and a Potential Hazardous Waste Preliminary Assessment Form (Appendix D) have been completed for the PA. Additionally, investigation area risks and pathways of concern are presented in a Conceptual Site Model (Appendix E). The following four pathways are evaluated based on EPA guidance:

- Groundwater migration
- Surface water migration
- Soil exposure
- Air migration

5.1 GROUNDWATER MIGRATION PATHWAY

The groundwater migration pathway evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release, hazardous substances to groundwater; 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, mobility, and quantity); and 3) the receptors (targets) who actually have been, or potentially could be, impacted by the release.

In accordance with EPA HRS guidance, an Observed Release is documented when there is an exceedance of three times the calculated background concentration or when an analyte is found at a concentration greater than the sample quantitation limit of the background sample if background levels are non-detect. The potential for risks to human health and the environment are also assessed by comparing the detected concentrations to the relevant State of Utah and EPA groundwater standards.

5.1.1 Geologic and Hydrogeologic Setting

5.1.1.1 Geologic Setting

The investigation area is the American Fork drainage in the Wasatch Mountains northeast of the cities of Lehi and American Fork, UT (Figures1 and 2). The Wasatch Mountains are part of the Middle Rocky Mountains physiographic province. The western side of the Wasatch Mountains forms the eastern boundary of the Basin and Range Physiographic Province and occurs west of the Wasatch Fault (Stokes, 1986). The Wasatch Fault is located approximately 5.2 miles west of the Tibble Fork Dam and is the structural element that separates the two provinces (NRCS, 2015b).

The American Fork Canyon area is an interesting segment of the Wasatch Range because it is in direct line with the powerful anticline of the Uinta Range (USFS, 2002a). Its structure contains both the north to south trending folds and thrusts of the Wasatch Range as well as large intrusive bodies from the Uinta Range (USFS, 2002a). In addition, pressure from the Uinta anticline has produced very complex structure, with unconformities, metamorphism, and striking overthrust faulting (USFS, 2002a).

Limestones and quartzites from the Mississippian and Cambrian Eras form much of the striking visible topography of the area (USFS, 2002a). These and the other sedimentary rock layers (including shale, conglomerate, dolomite, and tillite) contain three large masses of intrusive igneous rock (USFS, 2002a). These are aligned east to west in a line between the crest of the Uinta Mountains to the east, and the Oquirrh Mountains to the west, and occur north of American Fork Canyon (USFS, 2002a). However, smaller extensions of these reach into the canyon. Igneous dikes occur at the heads of MEG, and on the west side of Dry Creek extending east through the ridge to the head of Snake Creek (USFS, 2002a).

There are at least six significant faults which have produced very complex rock structures at MEG in American Fork Canyon (USFS, 2002a). An overthrust fault northwest of MEG, on the divide between American Fork Canyon and MEG, has created the unusual situation of older rock beds over younger ones (USFS, 2002a). Other nodes of structural complexity occur three quarters of a mile east of Pittsburg Lake and near the mouth of Dry Creek (USFS, 2002a). The Yankee, Globe, and Silver King mines are all associated with faults in MEG, and at least two faults occur in Major Evans Gulch, one noted in the Earl Eagle mine shafts, and another associated with Bay State mine (USFS, 2002a). A significant fault also trends across Dutchman Flat, and has several mines on or adjacent to it (USFS, 2002a).

The upper American Fork area is crossed by numerous faults, including the Silver Fork Fault near Mineral Flat, the Pittsburg Fault near Pittsburg Mine, the Dry Fork Canyon Fault, several faults in the MEG area, Dutchman Fault, and the Pacific Fault (USFS, 2002a).

5.1.1.2 Hydrogeologic Setting

Regionally, groundwater flows from the Wasatch Mountains west to the northern Utah Valley and the Jordan River. Groundwater flows laterally from the bedrock in the upper reaches of the American Fork River drainage basin to the carbonate-rock aquifers of the lower elevations along the American Fork River in the canyon. This groundwater is considered a major source of water to the basin-fill aquifers in the unconsolidated sediments in the lower half of the canyon and the northern Utah valley (Cederberg et. al., 2009). Basin fill contains fine-grained sediments near the center of the basin with coarse-grained sediments deposited near the basin margins, primarily as alluvial fans (Cederberg et. al., 2009). Primary porosity in the competent bedrock in the upper portions of the basin is low, therefore limiting the movement and storage of groundwater (Cederberg et. al., 2009). Secondary porosity from faults and fractures within the bedrock mountain block allow for greater ground-water movement and storage (Cederberg et. al., 2009). Secondary porosity within limestone is increased by dissolution channels as is evidenced by the caves at Timpanogos Cave National Monument located in the southern portion of the basin (Cederberg et. al., 2009).

The Wasatch Fault zone separates the Wasatch Mountains from the down-dropped graben that forms the Utah Valley basin (Cederberg et. al., 2009). The Wasatch Fault extends north along the Wasatch Mountains past American Fork Canyon as far as Dry Creek and follows Fort Creek along the east end of the Traverse Mountains, thereby separating the Traverse Mountains from the Wasatch Mountains block (Cederberg et. al., 2009).

5.1.1.3 Groundwater Levels

Pacific Mine is located on the uplands just above the riparian zone of the North Fork of American Fork River. Springs and seeps are found at lower elevations closer to the river (USFS, 2002a). The adit at Pacific mine discharges approximately 450 gpm indicating that the mine workings intersect the groundwater table (USFS, 2002a). Test drill holes in the areas of Pacific mine showed highly varying groundwater depths, some as close as one foot to the surface while one near the adit was dry at 20 ft. bgs (USFS, 2002a). Deeper groundwater is likely confined in a fracture flow system in the underlying intrusive bedrock. The presence of springs near the Pacific tailings indicated that the groundwater table intersects the surface in this area (USFS, 2002a).

Areas that are further from the river on benches and hillsides (e.g., Dutchman Flats and Bay State mine) (Figure 4) are free from springs and mine drainage (USFS, 2002a). The water table at Dutchman Flat does not intersect the monitoring wells that were installed at this site at a depth of 20 ft. bgs (USFS, 2002a). Dutchman Flat is even higher on the hillside than Dutchman and Pacific mines and probably sits even further above the water table (USFS, 2002a). Bay State is located in an area where the water table is probably not far below the natural ground surface during spring months (USFS, 2002a). This interpretation is based on the water table fluctuations in two monitoring wells located in the groin of the same hillside down the canyon a short distance (USFS, 2002a). The former Sultana Smelter sat on the edge of the riparian zone of the river but no springs were evident within the site indicating the water table is some distance below the surface (USFS, 2002a).

Investigation test pits and borings were completed in American Fork River at the current location of the Tibble Fork Reservoir between 1963 (prior to dam construction) and 2014. Pre-dam construction depth to water measured from test pits and drill holes ranged from 3 ft. bgs to 20 ft bgs with an average depth to water of 7.7 ft. bgs. One boring on the east bank drilled prior to dam construction had a depth to water of 45.3 ft. bgs. Boreholes drilled at the dam in 2013 had depth to water ranging from 0 to 25.2 ft. bgs with an average depth to water of 17.08 ft. bgs. Depth to water measured in test pits dug in the reservoir in 2014 at similar locations as the 2013 boreholes ranged from 2 to 12 ft. bgs with an average depth to water of 4.5 ft. bgs (NRCS, 2015b).

Depth to water is dependent on the altitude of the land surface and can range from about 150 ft near the mouth of the canyon to 400 ft in the Highland area in the valley (Cederberg et. al., 2009).

5.1.2 Groundwater Targets

For the targets component of this evaluation, the focus is on the number of people who regularly obtain their drinking water from groundwater sources that are located within 4 miles of the site (in accordance with EPA Site Assessment Guidance (EPA, 1992a). The emphasis is on drinking water usage over other uses of groundwater (e.g., food crop irrigation and livestock watering) because, as a screening tool, the EPA Site Assessment process is designed to give the greatest weight to the most direct and extensively studied exposure routes.

5.1.2.1 Drinking Water Sources

While there are 22 public water supply sources in and around the American Fork Canyon investigation area that could theoretically be affected, most of the sources for these systems are springs located upgradient of the American Fork River, or outside of the affected drainage (UDEQ, 2017b). Since water is presumed to follow the groundwater gradient it is unlikely that water being used is coming from the river or contaminated sources upstream, but rather from the topographic drainage above the spring (UDEQ, 2017b). Notably, these systems generally support transient, non-community populations and are not required to be sampled for metals, unlike community systems that are required to regularly monitor their sources for metals (UDEQ, 2017b).

According to a query of the Utah Division of Water Rights Well Drilling database, there are no potable groundwater wells within a 4-mile radius of the historical mining/potential source areas; however, there are a total of 22 public water sources (classified as springs) within a 4-mile radius of the potential source areas (Figure 5) (Utah Department of Natural Resources [UDNR], 2009). Of these, only two are within the American Fork watershed: a spring between two and three miles from an abandoned mine/potential source near the Silver Lake Summer Homes (in the Silver Creek drainage above North Fork American Fork), and a spring between three and four miles away near the Granite Lake Campground (in the Deer Creek drainage) (UDNR, 2009; EPA, 2017b). These springs supply a transient population and is not considered a full-time residential population.

For use in determining potential impacts to groundwater targets for the Site Assessment process evaluation, the average number of persons per household in Utah County, UT, is 3.62 (U.S. Census Bureau, 2010). The City of American Fork utilizes six municipal groundwater wells and two springs as the primary potable water supply for 45,007 people with 12,433 active connections (U.S. Census Bureau, 2010; Horrocks, et. al., 2007); however, all of the municipal wells and springs are located outside the 4-mile radius, and the springs are not hydrologically connected to the American Fork River (UDNR, 2009; UDEQ, 2017b).

5.1.3 Groundwater Sample Locations

Groundwater samples were collected by DWQ in 2001 from two monitoring well locations, Pacific Mine Well 02 (MLID 5912420) and Pacific Mine Well 03 (MLID 5912430) (UDEQ, 2017c), located approximately 0.30 miles southeast of the Pacific mine on the east side of the North Fork American Fork River and upgradient of the mine (Figure 5). Samples were also collected from three locations in the AF Canyon in 1998 by the USFS and in 2016 by UDEQ. The 1998 sample was collected from the Mile Rock Picnic Area water well (UDEQ, 2017d). Two (2) samples were collected in 2016 from Cave Camp Spring inside Timpanogos Cave National Monument and adjacent to MLID 4994984, and two (2) from the Gauging Station Spring near the old power station in lower American Fork Canyon (UDEQ, 2017d). The 1998 and 2016 data are being utilized for the purposes of this PA to document metals concentrations in potable supplies for the human health evaluation, as they represent locations downgradient of the source areas, and are discussed below. Groundwater samples are not being evaluated using HRS criteria to document an Observed Release because there are no appropriate downgradient samples (in terms of both flow path and timeframe) to allow a direct comparison of downgradient to upgradient samples. Sample location descriptions are presented in Table 2 and shown on Figure 5.

5.1.4 Groundwater Analytical Results Summary

Groundwater analytical results were compared to appropriate Utah Drinking Water Standards and EPA MCLs to determine if there is the potential for impacts to human health. For the evaluation of human health, all available groundwater sample results from above and below mines were compared to relevant Utah Drinking Water Standards and EPA MCLs in order to document metals concentrations in groundwater and determine if Utah Drinking Water Standards are exceeded.

One water sample, collected from the Mile Rock Picnic Area (owned by the USFS) in 1998, showed non-detect results for arsenic and lead, and a result for zinc that was within normal range for groundwater (UDEQ, 2017b; UDEQ, 2017d; UDEQ, 2018a). All detected concentrations were significantly below the Utah Drinking Water Standards and the EPA MCLs. Analytical results for this sample are presented in Table 5a.

American Fork City collected samples of its primary sources of drinking water in the canyon (Cave Camp Spring and Gauging Station Spring) on two different days in August 2016 in response to the sediment release from Tibble Fork Reservoir (Table 5a) (UDEQ, 2017b). These two springs are located next to the North Fork/American Fork River (UDEQ, 2017d). Despite their close proximity to the river, no heavy metals above the primary drinking water standards were detected in these samples (UDEQ, 2017b; UDEQ, 2018a). Because these springs are not hydrologically connected to the river, it is unlikely that there will be any heavy metal contamination associated with the American Fork River (UDEQ, 2017b).

Two samples were collected from two monitoring wells (not used for drinking water) adjacent to Pacific mine in 2001, prior to clean-up activities (Table 5b). Analytical results for lead (33.4 µg/L and 89.9 µg/L) exceeded the corresponding Utah Groundwater Quality Protection standard and the EPA MCL which are both 15 µg/L. Sample ID 5912430 significantly exceeded both the Utah protection standard (50 µg/L) and EPA MCL (10 µg/L) for arsenic with a concentration of 342 µg/L. The same sample exceeded the Utah Groundwater Protection Standard (5,000 µg/L) for zinc, which was detected at 9,260 µg/L. Sample 5912420 also slightly exceeded the EPA MCL for arsenic (10 µg/L) and was detected at 23 µg/L. Since these wells are not used for drinking water and the aquifer is not classified by the State, the exceedances of the Utah Groundwater Quality Protection standards and EPA MCLs are not necessarily relevant, but do indicate potential impacts to groundwater were occurring in the immediate area of the Pacific mine.

5.1.5 Conclusions

Although groundwater samples collected from the two monitoring wells (not used for drinking water) near Pacific mine indicated that groundwater near the site had been impacted, the samples were collected prior to clean-up activities at the mine.

There are no potable groundwater wells within a 4-mile radius of the potential source areas that are within the American Fork watershed and thus, could potentially be impacted by sources evaluated during this investigation. However, there are a total of 22 potable water sources (springs) within a 4-mile radius of the potential source areas (Figure 5). Of these, only two are within the American Fork watershed: a spring between two and three miles from a source at the Silver Lake Summer Homes (in the Silver Creek drainage above American Fork), and a spring between three and four miles away at the Granite Lake Campground (in the Deer Creek drainage) (UDNR, 2009; EPA, 2017b). These springs have not been monitored but supply a population that is not considered a full-time residential population. They are located upgradient of the North Fork American Fork River or outside of the affected drainage, but it is unknown if these springs are being impacted by other potential sources present within their respective drainages.

The City of American Fork utilizes six municipal groundwater wells and two springs as the primary potable water supply for 45,007 people with 12,433 active connections (U.S. Census Bureau, 2010; Horrocks, et. al., 2007). All of the municipal wells and springs are located outside the 4-mile radius and/or the springs (Silver Lake Summer Homes and the Granite Lake Campground) are not hydraulically connected to the American Fork River (UDNR, 2009).

There is a lack of groundwater sampling data from near the mine site sources from wells that are hydrologically connected to make a determination as to whether or not groundwater is being impacted near mine site sources; however, there is an absence of any documented impacts to drinking water sources associated with the investigation area. As discussed in Section 5.1.4, results from previous sampling of potable sources in the AF Canyon have not detected any metals above drinking water standards (UDEQ, 2017b). In addition, because groundwater is not the primary source of potable supplies within four miles of the mine sites and within the AF Canyon, and the two springs located between two and four miles of the mine sites are used for potable supplies to transient populations, groundwater targets are not likely to be impacted by potential sources in the AF Canyon.

5.2 SURFACE WATER MIGRATION PATHWAY

The surface water migration pathway evaluates: 1) the likelihood that sources at a site actually have released, or potentially could release, by overland flow or by flooding to surface water; 2) the characteristics of the hazardous substances that are available for a release (i.e., toxicity, persistence, bioaccumulation, and quantity); 3) the targets who actually have been, or potentially could be, impacted by the release.

In accordance with EPA HRS guidance, an Observed Release is documented when there is an exceedance of three times the calculated background concentration or when an analyte is found at a concentration greater than the sample quantitation limit of the background sample if background levels are non-detect. The potential for risks to human health and the environment are also assessed by comparing the detected concentrations to the relevant State of Utah WQS and other available benchmarks as discussed in Section 5.2.2.

5.2.1 Hydrologic Setting

The AF Canyon is located northeast and upstream of Utah Lake, southeast of The Great Salt Lake, southwest of the Jordanelle Reservoir, and west of the Deer Creek Reservoir (Figure 1), and comprises the northern half of the American Fork Canyon-Frontal Utah Lake watershed. The AF Canyon is located within the Wasatch Mountain Range at elevations ranging from approximately 5,000 ft amsl to 11,489 amsl (USFS, 2002a). The AF Canyon contains the headwaters of the American Fork River and its tributaries.

The North Fork American Fork forms the headwaters for the American Fork River and flows approximately two miles before its confluence with Dry Fork creek (Figure 6). From there, it flows approximately 1.5 miles to the confluence with Mary Ellen Creek, followed by Major Evans Gulch. North Fork American Fork continues through the canyon to the Tibble Fork Reservoir and approximately 6 miles to the confluence with the South Fork American Fork to form the American Fork River. American Fork River flows through Timpanogos Cave National Monument, adjoining with several tributaries along the way, through the Cities of Highland and American Fork, UT and ultimately to Utah Lake. The total distance from the North Fork American Fork River headwaters to Utah Lake is approximately 21 miles.

The flow in the American Fork River varies greatly from year to year depending on snow pack and precipitation events or periods of drought (USFS, 2002a). The mean annual discharge from 1996 to 2016 recorded from the single USGS gauging station (#10164500) located on the American Fork River, just downstream of Rock Canyon and approximately 7 miles downstream of the confluence with MEG, is 50.2 cfs (USGS, 2017).

The American Fork River and tributaries, from the mouth of American Fork Canyon to the headwaters of American Fork River, are designated as Class 2B = Infrequent primary contact recreation (e.g., wading, fishing); Use Class 3A = Cold water fishery/aquatic life; Use Class 4 = Agricultural uses (crop irrigation and stock watering) (UOAR, 2017).

The American Fork River’s main tributary is Mary Ellen Creek. From its headwaters, Mary Ellen Creek flows past the Globe and Yankee mines for approximately 2 miles before its confluence with the North Fork American Fork River. Table 6 presents flow rates collected from Mary Ellen Creek downstream of the mines and significant headwater tributaries as collected from April, 2016 to June, 2017 recorded a mean annual flow of 4.01 cfs (UDEQ, 2017c).

5.2.2 Surface Water Pathway Targets

For the targets component of this evaluation, the focus is on drinking water intakes, fisheries, wetlands, and other sensitive environments associated with surface water bodies within 15 miles downstream of a source. The emphasis is on drinking water intakes over other consumptive uses (e.g., food crop irrigation and livestock watering) because, as a screening tool, it is designed to give the greatest weight to the most direct and extensively studied route of exposure. In addition to this, the targets information, along with assessment of water quality standards (which indicates the potential impacts to aquatic species), sediment benchmarks, and other site-specific population and watershed information are used to assess whether there is the potential for other current or future imminent threats that would require additional or immediate attention by the EPA Emergency Response or Removal Program.

The 15-mile in-water segment, referred to as a Surface Water TDL, defines the maximum distance over which surface water targets are evaluated in the EPA Site Assessment process. The start of the TDL is defined by the probable point of entry (PPE) or the point at which entry of the hazardous substance(s) to surface water is most likely (EPA, 1992b). A site can have multiple PPEs (EPA, 1992b). Potential sources that are the focus of this PA (Lower Bog and Pacific Mine adit drainage, Miller Hill Tunnel and Yankee mine complex adit drainage and waste piles) and their PPEs are identified in Figure 6. The start of the TDL can also be the most distant sample point establishing an Observed Release (EPA, 1992b). Because there are two different tributaries with specific sources (that ultimately discharge to the American Fork River, North Fork American Fork and MEG, two TDLs were defined for this investigation area (Figure 6).

As is required for the Site Assessment process, the start of the 15-mile TDL for the North Fork American Fork River reach in-water segment is Miller Hill Tunnel, as this is the most downstream potential source area with a PPE on the North Fork American Fork River (Figure 6). The start of the 15-mile TDL for the MEG reach in-water segment and the Yankee mine complex source area is sample location 5912340, which is located just above its confluence with the North Fork American Fork River. This the most downstream location in MEG where concentrations of one or more metals (arsenic, cadmium, iron, and zinc) in samples collected in June and October 2016, and June 2017 met Observed Release criteria as discussed in Section 5.2.4.2.1. The 15-mile TDL for the Yankee mine complex ends on the American Fork River in American Fork City, approximately 4.5 miles before it enters Utah Lake.

The Site Assessment process also requires documentation of the longest overland flow pathway in the AF Canyon, which is the adit drainage from Pacific mine for the North Fork American Fork and flows approximately 0.23 miles before entering the North Fork American Fork River. The longest overland flow pathway for MEG is the adit drainage from Live Yankee Adit No. 1, which flows approximately 290 ft before entering MEG.

5.2.2.1 Surface Water Drinking Water Intakes and Diversions

As mentioned in Section 5.1.2, the City of American Fork utilizes two springs adjacent to the American Fork River within the 15-mile TDL as shown on Figure 6 (Surface Water Point of Diversion); however, these springs are not hydrologically connected to the American Fork River (UDEQ, 2017b). There are no surface water intakes used for potable drinking water within the 15-mile TDL (EPA, 2017b; UDNR, 2009).

The most downstream Surface Water Point of Diversion is used for irrigation and stock watering (Figure 6) (UDNR, 2009). Pleasant Grove Irrigation Company is the utility company that controls water from this diversion for the City of Cedar Hills. Water from the American Fork Canyon utilized by the City for irrigation flows into two retention ponds before being pressurized for residential irrigation use (City of Cedar Hills, no date). This system is not metered so there is no information available regarding the quantity of water delivered to households in Cedar Hills (Mulvey, 2016). According to the City of Cedar Hills, all households in Cedar Hills (approximately 4,560) use secondary water from American Fork Canyon (Mulvey, 2016); however, there is no location within the City that receives only American Fork Canyon water for irrigation purposes. Water used for irrigation also comes from Central Utah Project and culinary water (City of Cedar Hills, no date).

The Tibble Fork Reservoir is located in the approximate center of the American Fork Canyon on the American Fork River at the historic site of the Deer Creek terminus (now Tibble Fork Reservoir) and within the historic American Fork Mining District (Figures 2 and 4). Due to sediment deposition and subsequent sediment removal throughout its 50-year life, the reservoir currently provides 24 ac-ft. of sediment storage and 84 ac-ft. of flood storage for a total storage capacity of 108 ac-ft. (NRCS, 2015a). The dam provides flood prevention and sediment retention, Agricultural Water Management, as well as the secondary benefit of recreation (NRCS, 2015a).

5.2.2.2 Fisheries

Historically, the American Fork River, including Tibble Fork Reservoir has been a heavily used "put and take" fishery managed primarily for rainbow trout, with secondary management for brown and cutthroat trout (USFS, 1994). Possible catches also include brook trout. In the stream reach from MEG to the mouth of American Fork Canyon (approximately 11.6 miles), the UDWR stocked approximately 35,500 fish a year (USFS, 1994).

An important, but small, native cutthroat trout (Bonneville Cutthroat Trout [BCT]) population does overwinter and spawn in this reach of the American Fork drainage (USFS, 1994). The majority of fish caught in the drainage have been in there less than one year. It is common for those fishing to keep and eat the fish they catch (USFS, 1994). Currently, the BCT is a Utah Species of Greatest Conservation Need and managed under the classification N4/S4 (Apparently Secure - Uncommon but not rare; some cause for long-term concern due to declines or other factors) (UDWR, 2017; NatureServe, 2017). The state does not regularly stock the upper drainage, with the bulk of the population being BCT and managed under Utah general rules regarding trout harvest (four per day) (UDWR, 2017).

According to UDWR the BCT inhabit MEG up to the meadow below Yankee mine (UDWR, 2017). They are also known to be present in the North Fork American Fork almost up to the uppermost portion of MB (UDWR, 2017). Although it is noted that harvesting of fish in MEG and as far up as MB is thought to be extremely low, people could be consuming the fish (UDWR, 2017). EPA HRS evaluation requires documentation of the most downstream Observed Release location with respect to sensitive environments (fisheries) that are present within the 15-mile TDL. The meadow on MEG is approximately 1.5 miles upstream from the most downstream Observed Release location (Sample Location 5912340), which indicated that concentrations of arsenic, cadmium, iron, and zinc were more than three times the background concentration (meeting an "Observed Release" designation based on HRS criteria). This Observed Release is discussed further in Section 5.4.2.1,

As mentioned in Section 2.4.1, during the August 2017 site reconnaissance, a fisherman on the American Fork River just upstream of the Scotchman Adit 1 reported catching small brown trout and indicated that he did not eat what he caught, but released them back into the river.

As mentioned in Section 2.2.2.1, the ECOS and IPaC Threatened and Endangered Species databases list the Federally Endangered June sucker (*Chasmistes liorus*) as potentially associated with the study area (USFWS, 2017a; 2017b). A site-specific survey has not been performed; therefore, it is not possible to determine if this species is definitively present in the AF Canyon. However, this is a lake sucker endemic and unique to Utah Lake. The USFWS ECOS Threatened and Endangered Species Active Critical Habitat Report did not identify any critical habitat within the 15-mile TDL (USFWS, 2017a). Although the species is not reported to occur in the American Fork River consideration of metals concentrations and sediment loading from the upstream American Fork River is relevant since it ultimately discharges into Utah Lake, where the species is known to occur. Based on available data, metals concentrations are below all aquatic life WQS at sample locations prior to entering Utah Lake.

5.2.2.3 Sensitive Environments

According to the USFWS National Wetlands Inventory, Mary Ellen Creek and North Fork American Fork River from the headwaters to Tibble Fork Reservoir are identified as Riverine Upper Perennial Unconsolidated Bottom intermittently exposed with a few sections of Palustrine Scrub-Shrub seasonally flooded present on the North Fork American Fork River (USFWS, 2017c). Palustrine Forested temporary flooded wetlands are identified as present along the North Fork American Fork River from Tibble Fork Reservoir to the 15-mile TDL (USFWS, 2017c). As shown on Figure 6, there are approximately 14.6 miles of contiguous frontage present along the North Fork/American Fork River within the 15-mile TDL (USFWS, 2017c).

Timpanogos Cave National Monument encompasses approximately 200 acres and is located on the American Fork River approximately 2.2 miles from the mouth of AF Canyon. The North Fork/American Fork River also flows adjacent to the Lone Peak Wilderness. Both areas are considered Terrestrial Sensitive Environments and are located in the lower half of the AF Canyon (Figure 6).

5.2.3 Surface Water Sample Locations

Historically, surface water sampling has been conducted at various locations within the AF Canyon since 1980. The most comprehensive sampling of the majority of the watershed was conducted by DWQ in 2000 and included sample locations from the headwaters of the American Fork River to the mouth of the canyon, several tributaries, and major confluences. The second most wide-ranging sampling was conducted by the USFS from 2004-2007 and included the reaches near Lower Bog, Pacific, Yankee mines, and Dutchman Flats. This sampling data set was obtained during and after clean-up activities at those locations and other locations within these reaches. Lastly, monthly water quality monitoring has been conducted in MEG by Snowbird from April 2016 through present.

The 2007, one event in 2008, and the 2016-2017 sample results are the most recently collected and are being used in this PA to evaluate Observed Releases under HRS requirements, as well as evaluating the potential for impacts to human health and the environment using Utah WQS (as indicated in Section 3). Sample locations for three (3) segments that are the focus of this report are described below. Sample location descriptions are presented in Table 2 and shown on Figures 7a, 7b, and 7c.

The comprehensive sample data summary from 2000 is also included in this document for informational purposes as it documents the historical conditions in the watershed (Appendix F). The comprehensive sample data summary from 2000 is also included in this document for informational purposes as it documents the historical conditions in the watershed (Appendix F). A copy of the complete database was obtained from UDEQ DWQ, but only sample locations and pertinent information used in this PA were included in Appendix F for ease of review. Supporting information used in evaluation of the sample data in this PA are included in the complete database. A copy of the complete database can be obtained from UDEQ DWQ upon request.

Samples were analyzed for general chemistry and select dissolved metals. Results for aluminum, arsenic, cadmium, copper, iron, lead, nickel and zinc are being evaluated in this PA, as these are the only metals that have been detected consistently in surface water samples both historically and during the period being evaluated.

5.2.3.1 North Fork American Fork River – from Bog mine to MEG confluence

The segment includes the upper headwaters of the North Fork extending to just above the confluence with MEG (Figure 7a). There are several mines within MB and several tributaries that occur within this segment, including Dry Fork, Baker Fork, and Shaffer Fork. Of these, Baker Fork has a mine located within its drainage. Mine features, including adits and shafts, are also present within Dry and Bakers Forks tributaries, and along the North Fork American Fork within this reach above the confluence with MEG. There are two mines of primary concern, the Bog mine (including Lower Bog) and the Pacific mine, that occur in the upper drainage and adjacent to North Fork American Fork River. There is one draining adit at both the Lower Bog and Pacific mine and a waste pile at Lower Bog. The Dutchman Flat mine is located in the lower downstream portion of this segment and is just upstream of the confluence with MEG. Sample locations above and below the Dutchman mine were collected and evaluated for this segment.

Samples were collected from each of the two mine adits and upstream and downstream of the mine/waste areas, by the USFS in June and September 2007 (high and low flow events, respectively). The DWQ also collected samples from similar areas in October 2008. The sample identification numbers and descriptions are provided on Table 2 and shown on Figure 7a.

5.2.3.2 MEG – from upper tributary to confluence with North Fork American Fork

The segment includes the upper headwaters of MEG extending to just above the confluence with the North Fork (Figure 7b). There are several mines within MEG and several intermittently flowing tributaries that occur within this segment. Mine features, including adits and shafts, are also present within these tributaries and along MEG within this reach. There are two mines of concern, the Yankee mine and the Globe mine, that occur in the upper drainage and adjacent to MEG stream flow. The Yankee mine contains two draining adits, Live Yankee Adit No. 1 (a.k.a Yankee Mine Adit #4) and Yankee Adit # 1, that are discussed in this PA. The Live Yankee Adit No. 1 is the focus of the investigation at the Yankee mine. A total of nine samples were collected between April, 2016 and June, 2017 from the Live Yankee Adit No. 1 drainage (Sample ID 5912310). One sample from Yankee Adit #1 was collected in 2000 (Sample ID 5912280).

A total of nine samples from the Live Yankee Adit No. 1 and 17 samples from four locations upstream and downstream of the adit discharge were collected. Collected samples were representative of both high and low flow events as estimated based on flow measurements in Mary Ellen Creek reported between April 2016 and June 2017 (respectively) and discussed in Section 5.2.1. A review of the monthly data and flow rates indicates these months are generally representative of high and low flow events which represent best (high dilution of metals concentrations) and worst (no dilution of metals concentrations) case scenarios, respectively. The sample identification numbers and descriptions are provided on Table 2 and shown on Figure 7b.

5.2.3.3 North Fork/American Fork River - below MEG to mouth of canyon

The segment includes North Fork American Fork below the confluence with MEG extending down below the confluences with South Fork American Fork and Cattle Creek to just upstream of the cities of Cedar Hills and Highlands (Figure 7c). Tibble Fork Reservoir and three Surface Water Diversions occur within this segment of the American Fork River (Figure 6). There are several tributaries that occur within this segment, including Major Evans Gulch, Silver Creek, and Deer Creek, all of which have mines located within their drainage (Figure 7c). Mine features, including adits and shafts, are also present within these major tributaries. No mines of concern have been identified within this reach of the American Fork Canyon.

A total of 40 samples were collected from eight sample locations, including four locations upstream and downstream of the confluences with Major Evans Gulch and Silver Creek, one location in between, and three locations between Tibble Fork Reservoir and the mouth of the American Fork Canyon by the DWQ between June and September 2000. The sample identification numbers and descriptions are provided on Table 2 and shown on Figure 7c.

5.2.4 Surface Water Analytical Results Summary

Surface water analytical results were evaluated to 1) determine if an Observed Release has occurred, based on the HRS criteria of comparing the result of downstream sample results to three times the concentrations found in an upstream/background sample for each contributing source, and 2) compare detected concentrations to appropriate Utah WQS used to determine if there is the potential for impacts to human health and environment.

For the evaluation of human health and environment, all available surface water sample results (2000-2017) from the adits, and above and below mines were compared to relevant Utah WQS in order to: 1) identify contributions from each area; 2) determine if WQS are exceeded (indicating potential for impacts to the aquatic community or livestock via irrigation water); and; 3) identify changes or trends based on historical concentration data. The WQS evaluation is limited to evaluation of WQS associated with aquatic life and agriculture (livestock/irrigation). Since there are no drinking water intakes, surface water samples are not compared to drinking water standards.

5.2.4.1 North Fork American Fork River - from Bog mine to MEG confluence

5.2.4.1.1 Observed Release Evaluation

There are available data from above and below three potential source areas located in this segment. Only the most recent data available (2007 and 2008) are used in the Observed Release evaluation. A total of 14 downstream surface water sample locations in this segment were compared to results from the sample location upstream of each potential mine source discharge into the North Fork American Fork to determine if any of the detected concentrations in the sample(s) collected downstream of each mine site exceeded three times the background concentrations (Table 7a and Figure 7a).

Lower Bog

A total of four samples collected from two locations, upstream and downstream of the waste pile and adit discharge into the North Fork American Fork, were evaluated for the Lower Bog. The most recent surface water samples were collected in June and September 2007, representing high and low flow events, respectively. As shown in Table 7a, an Observed Release was documented for dissolved iron below the Lower Bog mine during the high flow period (June 2007) and an Observed Release was documented for zinc during the low flow event (September 2007).

Pacific Mine

A total of six samples collected from four locations, upstream and downstream of the adit discharge into the North Fork American Fork, were evaluated for the Pacific mine. Four of the most recent surface water samples were collected in June and September 2007 and October 2008, representing high (June) and low flow (September/October) events. Concentrations of dissolved cadmium and iron were detected in the October 2008 sample (Sample Location 5912120) at concentrations that exceeded the three times background concentrations meeting Observed Release criteria (Table 7a).

North Fork American Fork River below Pacific Mine

Surface water samples collected from two locations, upstream and downstream of the Miller Hill Tunnel waste piles and adit discharge to the North Fork American Fork, were evaluated to assess potential contributions from the mine site. A total of four of the most recent surface water samples were collected in June and September 2007, representing high and low flow events, respectively. Concentrations of dissolved iron (June 2007) and zinc (June and September 2007) were detected in the downstream sample location (SW-NF>DF) below the three times background concentrations, which did not meet Observed Release criteria. As a result, an Observed Release was not documented for this segment (Table 7a).

Although samples were collected from 2004-2007 from locations above and below the Dutchman Flat area (Sample Locations SW-NF>DF and SF-NF<DF), an Observed Release evaluation (uses the most recent sampling data) was not conducted for the site due to a lack of potential sources. Clean-up activities conducted in 2002-2003 at the site (as discussed in Section 2.3.2) encapsulated all waste materials associated with the site. Therefore, there are not currently any waste piles or draining adits associated with the site to warrant performing such an evaluation.

5.2.4.1.2 Evaluation of Human Health and Environment

There are available data from above and below three mines located in this segment. The available data are used to assess the potential impacts to human health and the environment and concentrations in the vicinity of each of the mine areas. The mines are listed in order from the headwaters of the North Fork of American Fork River to above the confluence with MEG.

Bog Mine - Lower Bog

A review of the most recent data for this segment, 2007, indicates that the adit discharge (Sample Location MD-LBAD) contained dissolved concentrations of cadmium, copper, iron, and zinc that were all above the 1-Hour (acute) and 4-Day (chronic) Average Utah Aquatic Wildlife WQS, and below the Agriculture WQS (Table 3b and Figure 7a). The concentration of dissolved lead was above the 4-Day Average (chronic) WQS. However, concentrations of all of the reported metals in the adit discharge were detected at significantly reduced levels in the closest downstream sample location (SW-NF<LB) in the North Fork American Fork (Table 7b). This indicates: 1) elevated metals in the adit discharge either precipitate out or adsorb/absorb to surrounding soil and vegetation, or other ameliorating conditions prior to entering the stream; and/or, 2) were diluted since the volume of discharge is insignificant relative to the flow in the North Fork American Fork.

In 2007, zinc was reported at 490 µg/L in the discharge from the Lower Bog adit (Sample Location MD-LBAD) (Table 3b), and while significantly lower concentrations were reported at the nearest downstream North Fork American Fork location (Sample Location SW-NF<LB), zinc concentrations more than double when comparing upstream Lower Bog versus downstream of the Lower Bog adit (22 µg/L versus 55 µg/L) as reported during the June and September 2007 sampling events (Table 7b). The zinc concentration that was observed during the high flow event (June 2007) was 41 µg/L similar to the September result. Iron was the only other metal that was elevated in both the adit discharge and in the downstream North Fork American Fork segment. All copper, zinc, and iron concentrations were below their corresponding aquatic and agricultural WQS (Table 7b). This indicates while there was metal loading and elevated concentrations discharging into the North Fork American Fork, detrimental impacts to aquatic life are not expected at the concentrations detected in the North Fork American Fork River below this mine based on these data.

Historically, surface water samples from upstream of Bog mine (Sample Location 5912010), upstream of Lower Bog adit (Sample Location 5912020), immediately downstream of Lower Bog adit (Sample Location 5912040), and downstream of Lower Bog (Sample Location 5912050) were collected from North Fork American Fork from June through September 2000 (Table 8 and Figure 7a). Analytical results from North Fork American Fork below Lower Bog adit indicated concentrations of cadmium and lead that exceeded the 4-Day (chronic) WQS. The June through September 2000 samples were collected prior to clean-up activities conducted in 2002-2003 (as discussed in Section 2.3.2). Based on a comparison of the cadmium, lead, and zinc concentrations reported in 2000 (Table 8) versus the 2004-2007 (Table 9a) analytical results at similar locations below the mine area, water quality has improved downstream of the mine and there were no exceedances to the Utah WQS as reported in the 2007 data.

Pacific Mine

A review of the most recent data for this segment, 2007-2008, indicates that the adit discharge (Sample Location MD-PMAD) contained dissolved concentrations of cadmium (8.2 µg/L) and especially zinc (1100 µg/L), which were the highest concentrations reported anywhere in the watershed (based on data reviewed for this assessment effort). Both elevated metals in the adit discharge were at concentrations above the 1-Hour (acute) and 4-Day (chronic) Average Utah Aquatic Wildlife WQS, and below the Agriculture WQS (Table 3b). Similar to the Lower Bog adit discharge, both cadmium and zinc concentrations were significantly reduced in the closest downstream North Fork American Fork sample location (SW-NF<PM) (Table 7b and Figure

7a). Similar to the Lower Bog mine adit, this indicates: 1) elevated metals in the adit discharge either precipitated out or adsorbed/absorbed to surrounding soil and vegetation, or other ameliorating conditions prior to entering the stream; and/or, 2) were diluted since the volume of discharge is insignificant relative to the flow in the North Fork American Fork.

In 2007, zinc was reported at 1,100 µg/L in the discharge from the Pacific mine adit (Sample Location MD-PMAD) (Table 3b). While there were significantly lower concentrations reported in the nearest downstream North Fork location (Sample Location SW-NF<PM and Sample Location 5912120), zinc concentrations were approximately double when comparing zinc concentrations in the North Fork American Fork upstream of the Pacific mine adit versus downstream of the Pacific mine adit (20 µg/L versus 53 µg/L) as reported during the June 2007 sampling event and again during the September and October 2008 sampling events (Table 7b). This is the same observation as indicated above for the Lower Bog mine results. The 2007 and 2008 zinc concentrations downstream of the Pacific mine were all below their corresponding aquatic and agricultural WQS (Table 7b). However, the 2008 result for the sample location in the North Fork American Fork downstream of the adit discharge (Sample Location 5912120) indicated that the concentration of dissolved cadmium was significantly elevated when compared to the location result upstream of the adit discharge, and was above both the 1-Hour (acute) and 4-Day (chronic) Average Aquatic Wildlife WQS (Table 7b). Cadmium above the 1-Hour Average (acute) WQS may cause impacts to aquatic life.

Historical results for the location (SW-NF<PM) below the Pacific mine from 2004-2007 are presented on Table 9a. Zinc concentrations immediately below the adit discharge were elevated in 2005 and 2006 with one exceedance of acute and chronic WQS on June 23, 2006, but then steadily decreased from 120 µg/L in June 2006 to 30 µg/L in September 2007 (Tables 9a and 9b).

Historically, surface water samples from upstream of Bog mine (Sample Location 5912010), upstream of Pacific mine (Sample Location 5912050), and immediately downstream of Pacific mine (Sample Location 5912120) were collected from North Fork American Fork from June through September 2000 (Table 8 and Figure 7a). Analytical results from North Fork American Fork below Pacific mine indicated concentrations of lead and mercury that exceeded the 4-Day (chronic) WQS. The June through September 2000 samples were collected prior to clean-up activities conducted in 20022003 and 2006 (as discussed in Section 2.3.2). Based on a comparison of the lead concentrations reported in 2000 (Table 8) versus the 2007/2008 analytical results (Tables 7b, 9a and 9b), water quality has improved downstream of the mine, except cadmium concentrations were in exceedance of Utah WQS based on the most recent available data from 2008.

Dutchman Flat Mine

The next downstream surface water sample locations in the North Fork are upstream of the Dutchman Flat mine (Sample Location SW-NF>DF on Figure 7a) and downstream of the mine (Sample Location SW-NF<DF). Surface water sample results indicate that cadmium was not detected, but the detection limit is significantly above the WQS, therefore it is unknown if there was a WQS exceedance at this location. Zinc was reported at 45 µg/L in June 2007 and not detected (<10 µg/L) in September of 2007; concentrations were below the sample-specific hardness calculated WQS (Table 7b).

Historical results for zinc concentrations in samples collected from above and below Dutchman Flat mine, and above MEG (Sample Locations SW-NF>DF and SW-NF<DF) indicate that zinc concentrations are relatively similar and were never reported above WQS (Table 9b). When results from these locations were compared to samples collected below Pacific mine (Sample Location SW-NF<PM), concentrations of zinc decreased with distance from Pacific mine. Zinc concentrations at the downstream-most location that is above the confluence with MEG (Sample Location SW-NF>DF) were 45 µg/L (June 2007) and non-detect (September 2007) in the two most recent sampling events in 2007 (Table 9a).

A relative comparison of available zinc concentrations from the upstream-most sample (Sample Location SW-NF>LB) versus downstream concentrations indicate that zinc was periodically slightly elevated, but within the same range throughout this segment, especially with regard to the 2006 and 2007 data (Table 9a). The historical zinc data from 2004 to 2007 indicate that zinc concentrations ranged from 11-79 µg/L in the upstream-most location (SW-NF>LB) and 10-87 µg/L below mining inputs (just above the confluence with MEG) (Sample Location SW-NF<DF), and only once exceeded WQS. If these concentrations are representative of typical conditions in this segment, then impacts to aquatic life related to zinc concentrations are likely to be low. The detection limit for cadmium for the historical sampling events from 2004 to 2007 is greater than the WQS, therefore it is not known if WQS were exceeded.

Historically, surface water samples from upstream of Bog mine (Sample Location 5912010), immediately downstream of Dutchman Flat (Sample Location 5912130), and upstream of MEG (Sample Location 5912140) were collected from North Fork American Fork in June 2000 (Table 8 and Figure 7a). Analytical results from North Fork American Fork above MEG indicated concentrations of lead that exceeded the 4-Day (chronic) WQS. These samples we collected prior to clean-up activities conducted in 2002-2003 (as discussed in Section 2.3.2). Based on a comparison of the lead concentrations reported in 2000 (Table 8) versus the 2007 (Tables 7b, 9a and 9b) analytical results, water quality has improved downstream of the mine and there were no exceedances to the Utah WQS as reported in the 2007 data.

Although metal loading and elevated concentrations of metals discharging from mines upstream into the North Fork American Fork have occurred, detrimental impacts to aquatic life are not expected at the concentrations detected in the North Fork American Fork in the reach below Pacific mine and above MEG.

According to the Utah DWQ, there is insufficient data in this reach (the headwaters of the North Fork of American Fork River to above the confluence with MEG) to determine if the state designated beneficial uses according to UAC Rule R317-2 Standards of Quality for Waters of the State (June 2017) (UOAR, 2017) are supported (UDEQ, 2018b).

5.2.4.2 MEG – from upper MEG tributary to above confluence with North Fork

5.2.4.2.1 Observed Release Evaluation

Available data in MEG from most-upstream tributaries versus MEG downstream at mouth prior to discharge into the North Fork American Fork were compared. This includes two unimpacted upstream background locations compared to three downstream locations within MEG (Table 10a and Figure 7b). This evaluation documents whether an Observed Release is documented to the MEG tributary prior to discharging to the North Fork American Fork.

Comparison of the two upstream background samples in MEG versus downstream of all mine discharges in MEG are shown on Table 10a. During the June 2016 high flow event, zinc and cadmium concentrations meet the criteria for an Observed Release in all downstream locations (to the mouth of MEG). The concentration of iron met Observed Release criteria in the June 2016 event at one location farther downstream of the mines. During the October 2016 low flow event, zinc concentrations at only one mid-tributary location (downstream of the mines) continued to indicate an Observed Release. Arsenic qualified as an Observed Release at all three downstream locations within MEG. Additional more recent results are available for May and June 2017 and indicate that concentrations of cadmium and zinc were consistently at least three times background (meeting Observed Release criteria). The concentration of aluminum also meets Observed Release criteria in the May 2017 sample location farther downstream of the mines. Arsenic, copper and iron also meet Observed Release criteria at all downstream locations evaluated in MEG (Table 10a).

5.2.4.2.2 Human Health and Environment Evaluation

There are available data from above and below the Yankee mine complex in this segment. The available data are used to assess the potential impacts to human health and the environment and concentrations in the vicinity of each of the mine areas. The mines are listed in order from the headwaters of MEG to just above the confluence with the North Fork of American Fork River.

Yankee Mine Complex

A review of the most recent data for this segment, April 2016 through June 2017, indicates that the Live Yankee Adit No. 1 discharge located in the headwaters of MEG (Sample Location 5912310) contains dissolved concentrations of zinc that are consistently above the 1-Hour (acute) and 4-Day average (chronic) Utah Aquatic Wildlife WQS for all months sampled, and cadmium, iron, copper, and mercury exceed one or both WQS periodically (Table 10b). However, all metals concentrations detected in the adit drainage, except dissolved cadmium and zinc, drop below WQS in downstream samples collected in MEG (Sample Locations 5192320 and 4995000), (Table 10b and Figure 7b). This indicates elevated metals in the adit discharge either 1) precipitate out or adsorb/absorb to surrounding soil and vegetation, or encounter other ameliorating conditions prior to entering the stream; and/or, 2) are diluted since the volume of discharge from the adit is insignificant relative to the flow in MEG.

Concentrations of cadmium in the drainage from Live Yankee Adit No. 1 (Sample Location 5912310) range from not detected to 4.0 µg/L and periodically exceed 4-Day (chronic) Aquatic WQS with one exceedance of both WQS (Table 10b). Cadmium concentrations were consistently reported above the chronic aquatic WQS at all downstream locations ranging from 0.4 µg/L to 0.7 µg/L. Zinc was reported at concentrations ranging from 260-880 µg/L in the adit discharge while significantly lower concentrations were reported at the nearest downstream MEG location below the mine waste (Sample Location 5912320). Zinc concentrations ranged from 50 µg/L to 200 µg/L and periodically were reported above both the 1-Hour (acute) and 4-Day (chronic) Aquatic WQS at the two closest downstream locations below the adit discharges and tailings piles. All zinc and cadmium results at all locations for all available sample dates are below agricultural WQS (Table 10b).

This indicates that while there is metal loading and elevated concentrations of metals discharging into MEG, exceedances of zinc and the potential impacts to aquatic life are observed in a relatively small downstream segment in upper MEG, but levels of concern drop below WQS and elevated concentrations do not discharge to the North Fork American Fork River. However, consistent elevated concentrations and loading of cadmium to MEG are occurring upstream and downstream from mine sites, indicating the potential for impacts to aquatic life, some of which may be naturally occurring.

According to the Utah DWQ, there is insufficient data in this reach (the headwaters of MEG to above the confluence with the North Fork of American Fork River) to determine if the state designated beneficial uses according to UAC Rule R317-2 Standards of Quality for Waters of the State (June 2017) (UOAR, 2017) are supported (UDEQ, 2018b).

5.2.4.2.3 Metals Loading

Data are available to assess the metals loads to MEG. As discussed in Section 2.3.2, the 1999-2000 USGS mass loading studies conducted in the American Fork Canyon and MEG identified large contributions of iron and zinc from the Yankee Mine and associated tailings piles (Cirrus, 2016a; Kimball et. al., 2009). The study also indicated that loading to the American Fork River from groundwater inflow downstream from MEG was significant, and based on the 2000 study, this groundwater contribution was the most substantial metal loading in MEG for several metals (copper, iron, and manganese) (Kimball and Runkel, 2009).

In addition, samples collected by Lidstone and Anderson in 1993 at approximately 1,000 feet below the North portal discharge (presumed to be the Live Yankee Adit No. 1) were compared to samples collected in the USGS study from the same location. This comparison showed dramatic reductions in all metals concentrations between 1993 and 2000 and all samples collected during the USGS investigation met State WQS (Cirrus, 2016a and 2016b; Lidstone and Anderson, 1993; Kimball et. al., 2009).

Improved water quality conditions in Mary Ellen Creek downstream of the Live Yankee Adit No. 1 discharge were the result of rerouting flows away from the tailings pile in 1997 (Cirrus, 2016a and 2016b; Lidstone and Anderson, 1993; Kimball et. al., 2009). Based on the comparison of results from these reports, there was heavy metal loading occurring in MEG; however, when the discharge from Live Yankee Adit No. 1 was rerouted, there was no need for further clean-up (Cirrus, 2016a). In addition, as noted by Cirrus, as long as the Quartzite tailings piles were not disturbed by development, the diversion of flows from the Live Yankee Adit No. 1 kept away from the tailings, or there was no summer traffic on those tailings, there should be no cause to revisit the decision that no further remedial action was needed (Cirrus, 2016a; Kimball et. al., 2009; Kimball and Runkel, 2009).

<u>Current Metals Loading In Mary Ellen Gulch</u>

An evaluation of metal loading in MEG was conducted based on sample analytical results and flow rates from April 20, 2016 to June 16, 2017 at various locations along MEG in order to assess the current status of metals loading to MEG.

This evaluation included sample locations 5992274, 5992277, 5912317, 4995000, 5912320, 5912340 (Figure 7b).

- Locations 5992274 and 5992277 are upstream of mining activities in the MEG area and were used as background locations to evaluate baseline conditions prior to mining impacts.
- Location 5912317 is downstream of the Yankee mine adit discharge and directly downgradient of the tailings runoff into Mary Ellen Creek and is used as a source sample to evaluate metal loading introduced by mining operations.
- Location 5912320 is directly downstream of the Yankee mine adits, tailings piles, and groundwater seeps present in MEG and represents conditions after MEG receives surface water and groundwater impacted by historic mining operations.

By comparing the metal loading at locations downstream of the Yankee and Globe mines discharges combined with groundwater seeps (Sample Location 5912320) versus Yankee and Globe mines discharges without groundwater seeps (Sample Location 5912317), provides an estimate of potential metal loading introduced to MEG by groundwater. Sample Locations 4995000 and 5912340 are further downstream of the mining influences which help to provide some context as to how the metal loading changes in MEG, which may be related to soil retention of metals, uptake by vegetation, and potential influence by discharges of surface water and groundwater into the creek. Surface water sample locations are shown of Figure 7b, loading volumes are summarized in Table 11, and monthly metals loading by analyte are presented in Graphs 1-3. Metal loading was assessed during high flow (April through July) and low flow (August through March) periods.

The metal loading for several key metals including arsenic, cadmium, copper, iron, lead, and zinc was evaluated at combined background locations in upper MEG (Sample Locations 5992274 and 5992277) versus a location that is immediately downstream of Yankee mine (Sample Location 5912317) to determine if the Yankee Mine adit and tailings pile to determine metals loads (pounds per day [lbs/day]) being added to MEG by the adit and tailings piles. In addition, and immediately following the loading evaluation from the Yankee and Globe mines waste, loading from an area of groundwater seeps below (Sample Location 5912320) mine waste is also assessed. Metal loading to MEG by contaminant is presented in Table 5-1.

Table 5-1 - Metal Loading to MEG

Source:	Yankee and Globe Mines Waste Excluding Groundwater Seeps	Yankee and Globe Mines Waste Including Groundwater Seeps
Metal		
Aluminum	Aluminum loading was insignificant.	The aluminum metal loading during high flow increased by 2.5 – 3.4 pounds per day in May 2017 (Difference in metal loading between 5992277 and 5912320 during May 2017 and difference in loading between 5992277 in May 2016 and 5912320 in May 2017). The average

Source:	Yankee and Globe Mines Waste Excluding Groundwater Seeps	Yankee and Globe Mines Waste Including Groundwater Seeps
		metal loading increase during periods of low flow was around 0.18 lbs/day (Average difference in metal loading December 2016 – March 2017 at locations 499500 and 5912320).
Arsenic	Arsenic loading increased by approximately 0.01 lbs/day during high flow (April through July) (Difference in metal loading between 3912320 and 5912317) and 0.0076 lbs/day during low flow (August through March) (Average difference in metal loading between 5912317 and 5992277).	The increase in arsenic metal loading during periods of high and low flow was found to be consistent with some periods during high flow showing an increase close to 0.02 lbs/day (Difference in metal loading between 5912320 and 5912317 on 6/16/2017).
Cadmium	Cadmium loading increased between 0.007 to 0.024 lbs/day (compared to background metal loading) during periods of high flow (Difference in metal loading between 5912317 and 592277 in May and June 2017).	Cadmium loading was increased due to groundwater seeps was the highest during periods of high flow but noticeable increases were still present during low flow periods. The highest metal loading increase was during May 2016 where the groundwater seeps contributed 0.028 lbs/day of the cadmium loading (Difference in metal loading between 5912320 and 5912317 in May 2016).
Copper	Copper loading also increased as compared to background by 0.018 to 0.089 lbs/day during periods of high flow, but during periods of low flow, the metal loading for copper decreased compared to background (Difference in metal loading between 5912317 and 592277 in May and June 2017).	Copper metal loading was determined to be higher in MEG as a result of groundwater seeps as well. Increases were prevalent during high flow periods. The overall metal loading increased by as much as 0.1-0.6 lbs/day as a result of groundwater seeps during high flow periods but the increase was much less substantial during low flow (Max and min of the difference in metal loading each month between locations 5912320 and 5912317 April - July 2016 and April - July 2017).
Iron	The iron loading significantly increased by as much as 1.5 lbs/day contributing higher iron compared to the background loading (Max difference in metal loading between 5912317 and 592277 during November 2016). Iron loading was consistently higher due to the mine adit and tailings pile during both high and low flow periods.	Iron loading increased during periods of high flow and generally increased between 0.4 to 1.1 lbs/day as a result of groundwater seeps (Range of the difference in metal loading each month between locations 5912320 and 5912317 April - July 2016 and April - July 2017).
Lead	Lead loading increased due to the mine adit drainage and tailings pile during periods of high and low flow. The lead metal loading increased by as much as 0.008 lbs/day (Difference in metal loading between 5912317 and 592277 in May 2017) compared to background loading.	Lead loading showed the most substantial increase during May of both 2016 and 2017. During those months the metal loading increased 0.017-0.03 lbs/day (Difference in metal loading between locations 5912320 and 5912317 in May 2016 and May 2017) as a result of groundwater seeps. Lead loading in MEG fluctuated between increasing slightly and decreasing slightly during low flow periods.

Source:	Yankee and Globe Mines Waste Excluding Groundwater Seeps	Yankee and Globe Mines Waste Including Groundwater Seeps
Zinc	Zinc loading was also substantially increased from background conditions during periods of both high and low flow. Zinc load increases ranged from 0.073 to 3.6 lbs/day between May 2016 and June 2017 and increased in May of 2017 (Range of the difference in metal loading between 5912317 and 592277 during specified timeframe).	Zinc metal loading in MEG was increased due to groundwater seeps during periods of both high and low flow. The increase in zinc metal loading due to groundwater seeps was most pronounced during periods of high flow where metal loading increased by 0.32 lbs/day to 2.9 lbs/day (Difference in metal loading between locations 5912320 and 5912317 April – July 2016 and April –June 2017).

Based on the loading analysis above and below groundwater seeps associated with Yankee mine, the Yankee and Globe mines adit and tailings piles (excluding impacts from groundwater seeps) were found to contribute significant sources of arsenic, cadmium, copper, iron, lead, and zinc to MEG. Metals loading during high flow events increased substantially for aluminum, arsenic, cadmium, copper, iron, lead, and zinc due to groundwater seeps at the Yankee mine complex (at sample location 5912320 shown on Figure 7b).

Additionally, metal loading downstream of the adit and tailings piles was compared to the Yankee mine waste area (Sample Location 5912320) and downstream at the mouth of MEG (Sample Location 5912340) to determine if metals loading changes as it flows to downstream in MEG and prior to discharging to the North Fork American Fork River. Aluminum loading was shown to increase during high flow periods as MEG proceeds downstream towards the confluence with North Fork American Fork River with the largest loading increase of 1.5 lbs/day; however, during periods of low flow, the metal loading fluctuates between increasing and decreasing as you move downstream. Arsenic, cadmium, copper, iron, lead, and zinc loading fluctuates between increasing and decreasing downstream along MEG, therefore, a trend could not be established.

5.2.4.3 North Fork American Fork - confluence with MEG to mouth of canyon

5.2.4.3.1 Observed Release Evaluation

Samples from North Fork American Fork River immediately upstream of the confluence with MEG (sample location 5912140) and the North Fork American Fork River immediately downstream of the confluence with MEG (sample location 5912150) were compared (Table 12a and Figure 7b). This evaluation identifies whether an Observed Release is documented to the North Fork American Fork River *from* MEG.

The available results from June 2000 are shown on Table 12a. The concentrations of all detected metals discharging from MEG versus those detected in the downstream North Fork American Fork immediately below MEG are similar and do not represent an Observed Release based on HRS requirements.

5.2.4.3.2 Human Health and Environment Evaluation

There are a total of nine sample locations in this segment beginning immediately downstream of the confluence of MEG discharge into North Fork of American Fork and ending at the mouth of

American Fork Canyon (Figure 7c). The nine samples bracket key tributaries (upstream and downstream) starting with MEG, then Major Evans Gulch, Silver Creek, downstream of Tibble Fork Reservoir/ upstream of South Fork American Fork, and ending at the mouth of American Fork Canyon. Historical sampling at these locations was conducted from 1992 through 2000. Only the most recent results collected in June 2000 and September 2000, one sample location in 2004, and one sample location in October 2011, which represent high and low flow event periods, respectively, are presented in Table 12b. Based on a review of the existing results from Utah DWQ (Appendix F, 1992 through 2000) for representative metals and sample locations throughout this segment, it is noted that metals were generally not detected at elevated concentrations and there is not a large degree of variability between years or between high and low flow event periods for the same year. The results for four representative reaches are presented in the sections below.

North Fork American Fork River downstream of MEG. Sample Location 5912150 is directly downstream of MEG (Figure 7c). The location was sampled in 2000 and again in 2011. A review of the range of concentration results for several key metals over the historical sample period indicates that events were completed during representative high and low flow months (June and September 2000, and October 2011) (Table 12b). Zinc was detected during each event and ranged from 56.8 µg/L in June 2000 to 40.1 µg/L in September 2000 and consistently decreased between each event. In October 2011, zinc was reported at 28.1 µg/L. All zinc concentrations were below all relevant WQS. As presented on Table 12b, other metals including aluminum, lead, and iron were also detected at relatively low concentrations all below WQS, except lead. Lead was detected above the aquatic WQS on two consecutive days in June 2000, which was the only time that the concentration was above the 4-Day Average (chronic) WQS. The samples obtained during 2000 were collected prior to clean-up activities in the upper watershed which was conducted in 2002-2003 and 2006 (as discussed in Section 2.3.2). Based on a comparison of the lead concentrations reported in 2000 (3.4 µg/L) versus the October 2011 analytical result (0.35 µg/L), lead concentrations decreased by an order of 10 and water quality in the North Fork American Fork has improved downstream of the confluence with MEG.

Table 12b presents the comparison of concentrations from North Fork American Fork immediately upstream of the mouth of MEG (Sample Location 5912140) versus North Fork American Fork immediately downstream of the MEG confluence (Sample location 5912150). The comparison indicates that dissolved aluminum, iron, lead, and zinc were similar or slight decreases in the upstream MEG sample versus the downstream North Fork American Fork sample location. Lead was reported at 5 µg/L in the upstream MEG sample, and from 3.4 to 3.5 µg/L in the downstream North Fork American Fork sample, these concentrations were above the 4-Day Average (chronic) WQS. It is notable that lead and all other metal concentrations are mostly not detected, and when detected are below WQSs within a short distance in the next downstream sample locations (5912170 and 5912180) in the North Fork American Fork (Table 12b; Figure 7c).

North Fork American Fork River from Silver Creek to Tibble Fork Reservoir. Sample locations 5912190, 5912200 are downstream of Silver Creek, and sample location 5912820 is from within Tibble Fork Reservoir (Figure 7c). Sample Locations 5912190 and 5912200 were sampled in 2000 during the months of June, July, August, and September. In general, zinc was detected at relatively low concentrations, below WQS, ranging from 42 µg/L (Sample Location 5912190) in June to 35.1 µg/L (Sample Location 5912200) in September 2000. As presented in Table 12b, other metals including aluminum, lead, and iron were also detected at relatively low concentrations all below WQS, except lead. Lead was detected at 3.6 µg/L in June 2000 (Sample Location 5912190), which was the only sampling event that the concentration was above the 4-Day Average (chronic) WQS. The samples obtained in 2000 were collected prior to clean-up activities in the upper watershed which was conducted in 2002-2003 and 2006 (as discussed in Section 2.3.2). The data suggest that although lead was detected in one sample at a concentration exceeding WQS, lead was generally not detected at elevated concentrations, and detrimental impacts to aquatic life are not expected at the concentration detected in this reach of the North Fork American Fork River.

Sample Location 5912820 is located within Tibble Fork Reservoir and adjacent to the dam (Figure 7c). This sample location was sampled by the Utah DWQ every other year from 1981- 2001, in June 2005, and lastly in August 2010 (Appendix F). Zinc was detected at relatively low concentrations, below WQS, ranging from 25 µg/L in August 1981 to 94.0 µg/L in June 1991. Other metals including arsenic, iron, and manganese were also detected at relatively low concentrations all below WQS. Lead was detected at 10 µg/L in June 1981, 1989, and May 1991, which was above the 4-Day Average (chronic) WQS. Copper was also detected at 10 µg/L in June 1981, which was above the 4-Day Average (chronic) WQS. Although lead and copper were detected in samples at a concentration exceeding WQS in some sample years, generally concentrations were not above WQS and there have been no reported exceedances in the data since 1991.

The Utah DWQ monitors the Tibble Fork Reservoir for state designated beneficial uses of the waterbody (UOAR, 2017). The use classes are protective of recreation including, but not limited to, wading, hunting, and fishing, cold water species of game fish and other cold water aquatic life, and agricultural uses including irrigation of crops and stock watering according to UAC Rule R317-2 Standards of Quality for Waters of the State (June 2017) (UOAR, 2017). This monitoring includes the collection of water for dissolved metals. According to the DWQ records, the reservoir currently meets the state criteria for these designated uses (UDEQ, 2018b).

American Fork River Immediately Below Tibble Fork Reservoir

Sample location 5912810 is located on the North Fork American Fork River just downstream of the Tibble Fork Reservoir dam (Figure 7c). Historical sampling at this location was conducted in June 1981, and June and September 2000. Only the most recent results collected in 2000, which represent high and low flow event periods, (June and September respectively), are presented in Table 12b. Zinc was detected at 39 µg/L in June 2000, which is significantly below both Utah WQS of 191.9 µg/L (acute) and 193.5 µg/L (chronic). Iron was the only other metal that was detected and was also at concentrations significantly below WQS. These samples were collected prior to clean-up activities in the upper watershed which was conducted in 2002-2003 and 2006 (as discussed in Section 2.3.2). Analytical results indicate that water discharging from the reservoir was of high quality and there were no exceedances to the Utah WQS as reported in the 2000 data.

American Fork River at mouth of American Fork Canyon above Cedar Hills and Utah Lake. Sample Location 4994980 is the downstream-most sample location at the mouth of American Fork River, and located upstream of the towns of Cedar Hills and Highland. The river ultimately discharges within approximately 7.5 miles downstream of this sample location into Utah Lake

(Figure 7c). Extensive historical sampling at this location was conducted from 1992 through 2005, which included 4 to 7 months/year (Appendix F). In general, very few dissolved metals were detected in any year, but when detections were reported, all results were below all WQS. Based on a review of the existing results from Utah DWQ for representative metals and sample locations throughout this segment (Appendix F, 1992 through 2005), it is noted that metals were generally not detected at elevated concentrations and not a large degree of variability between years or between high and low flow event periods for the same year.

Only the most recent results collected in June and September 2000 and July and October 2004, which represent high and low flow event periods, respectively, are presented in Table 12b. Dissolved zinc was not detected during any of the 21 sampling events spanning 13 years (Appendix F). In addition, other dissolved metals, such as manganese, were infrequently detected at relatively low concentrations well below WQS. The data suggest that high quality water was discharging from the American Fork River canyon upstream of Utah Lake.

5.2.5 Sediment Sample Locations

Sediment samples were collected from locations along the North Fork American Fork between upstream of Tibble Fork Reservoir and the mouth of the canyon. A total of five core locations (Core 1-TF through Core 5-TF) were collected within Tibble Fork Reservoir in 2010 by NRCS and used to characterize sediments within the reservoir (NRCS, 2015b). A total of five locations (5912840, 5912810, 4994990, 4994984, and 4994980) on the North Fork American Fork between just upstream of Tibble Fork Reservoir and the mouth of the canyon were collected by the UDEQ on three separate days in August 2016 following the inadvertent sediment release from Tibble Fork Reservoir (UDEQ, 2016a). Sample Location 5912840 is located immediately upstream of Tibble Fork Reservoir with the remainder of the samples located from below the reservoir to the mouth of the canyon. These samples were used to characterize sediments within American Fork Canyon downstream of the reservoir. Sample locations are described below and in Table 2 and shown on Figure 8.

The sediment data are not being evaluated to document an Observed Release since sediment samples have not been collected from the reach and tributaries above the reservoir, which would be needed to document background conditions. However, post-release sediment data downstream of the Tibble Fork Reservoir are being assessed in this PA for informational purposes only. Tibble Fork Reservoir, which is under the jurisdiction of the UDEQ, has a separate process in place to evaluate and remediate conditions resulting from the release.

5.2.6 Sediment Analytical Results Summary

Two relatively recent historical sediment sampling events were conducted in 2010 and 2016, both associated with the Tibble Fork Reservoir. Analytical results from the sampling events are available from Tibble Fork Reservoir bottom sediment (NRCS, 2015b) and from North Fork American Fork above and below Tibble Fork Reservoir as associated with the inadvertent 2016 dam breech which released sediment into the North Fork/American Fork River (UDEQ, 2016a). Analytical results from core samples from within the reservoir are presented in Table 13a. While there are no upstream or background core sediment samples for a direct comparison of metals concentrations, a review of the metals concentration from the 0-6 inch portion of TF- Core 2-TF (Table 13a) can be compared with surface sediment from North Fork American Fork upstream of the reservoir for relative comparison (Sample 5912840 as shown on Table 13b). Though this is not an ideal comparison, since sediment samples were collected from two different years, it provides some insights into the metals concentrations coming into the Reservoir versus depositional concentrations within the Reservoir. Concentrations of arsenic, cadmium, copper, lead, mercury, silver, and zinc are all at least three times greater in the Reservoir, documenting the metals input and accrual from upstream sources.

The analytical results associated with sediment sampling conducted by the UDEQ in the North Fork/American Fork River after the Tibble Fork Reservoir sediment release during August 2016 are presented in Table 13b. The river sediment sampling was conducted in response to an inadvertent release of sediment from the Tibble Fork Reservoir. Sediment samples were collected from an upstream location as well as from depositional areas in the river above and below the Tibble Fork Reservoir at four locations including at the mouth of the American Fork Canyon (Figure 8). The UDEQ report concluded:

- Concentrations of metals in American Fork sediment were greater in the samples collected downstream of the Tibble Reservoir when compared to upstream of the reservoir.
- Metals concentrations generally increased with distance further downstream of the reservoir, with the most elevated metals concentrations in the American Fork above the confluence with the South Fork American Fork River.
- Lead concentrations were compared to and exceeded human health soil screening benchmarks for soil that were used since there are no human health sediment screening benchmarks available.
- EPA Region III BTAG Freshwater Sediment aquatic life benchmarks* for arsenic, cadmium, copper, lead, manganese, nickel, and zinc were exceeded downstream of the reservoir. Sediment concentrations of arsenic, cadmium, lead and zinc were also reported above the EPA 2006 sediment benchmarks in the sample above the Tibble Fork Reservoir, but the exceedance of the benchmark was much greater in the downstream samples.
- Most importantly, the UDWR reported an intact benthic macroinvertebrate community above the reservoir and in the lower portion of American Fork River, below the confluence with the South Fork American Fork. The macroinvertebrate community in the 2-mile stretch directly below Tibble Fork Reservoir appeared to be heavily impacted by the sediment release (UDEQ, 2016a), which is the same river segment that experienced a fish kill in between August 19 and August 22, 2016.

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*Table 13b presents the sediment results from the UDEQ sampling event and compares the detected metal concentration in North Fork American Fork River sediment with two different aquatic life sediment benchmarks including a consensus-based Threshold Effect Concentration (TEC) (MacDonald et.al., 2000; EPA, 2006) and a consensus-based probable effect concentration (PEC) (Ingersoll et.al., 2000). The UDEQ report (UDEQ, 2016a) cited and used the TEC for the comparison of detected metals in sediment at the American Fork. Both aquatic life consensus-based benchmarks are presented to provide the range of threshold concentration versus probable effect concentrations based on the available sediment benchmarks.

Concentrations of antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, nickel, and zinc exceeded sediment TECs downstream of the reservoir. A comparison to the PEC indicates that while there are a few minimal exceedances of arsenic, cadmium, and zinc (relatively low magnitude of exceedances), the exceedances are not widespread and are not observed during the final sampling event (Table 13b). Results indicate that concentrations of all metals notably decreased from just after the initial sediment release (August 23rd) when compared to the August 28th sample results.

Lead concentrations are observed above the PEC benchmark throughout the downstream reaches to the mouth of the canyon, and remained above the benchmark during the final sampling event. The exceedance of the benchmarks does not signify that effects are occurring, rather, may identify metals and locations that additional sampling or follow up is recommended.

The UDEQ report includes human health sediment screening results (UDEQ, 2016a, page 11), in which the EPA Residential RSL for lead, 400 mg/kg (EPA, 2017a), was used for comparison to detected lead concentrations in sediment. While this is not a standard EPA practice for use of the soil RSL, it is notable that the conservative soil benchmark was only exceeded once, indicating that the potential for human health risks is de minimis. For example, the lead benchmark from the EPA RSL – Residential Soil Table is derived based on a number of exposure assumptions associated with a resident being in daily contact for 365 days/year with the lead-contaminated area/incurring direct and incidental uptake of lead (including ingestion, dermal contact, and inhalation of the contaminated soils), which is not the case or comparable to the occasional exposure to submerged streambed sediment in the American Fork River. While the data suggest that sediment metals concentrations are elevated downstream of the reservoir when compared to upstream, the fact that only one location was above the conservative residential soil screening level as presented in the 2016 UDEQ report suggests that elevated concentrations of lead that could be of concern related to human health are extremely limited. It also provides some indication that the lead concentrations are not likely to be sufficiently elevated to result in regular exceedances of the Residential RSL if sediment were transported and were deposited as soils in residential areas.

The results of the macroinvertebrate survey (UDEQ, 2016) indicate that there were impacts to the benthic community in the 2-mile stream reach directly below the Tibble Fork Reservoir. Based on the similarity of the sediment metals concentrations in the reaches with invertebrate communities versus without invertebrate communities (compare UDEQ upstream sample 4994990 with downstream sample 4994984), and the fish kill that occurred in the same reach at the same time, it is likely that impacts to the macroinvertebrate community in the 2-mile downstream reach is at least partially related to the physical smothering/clogging action hindering respiration and elimination/reduction of benthic habitat (e.g., filling in of sediment interstitial pore space).

While there are data limitations associated with the evaluation of impacts from the recent Tibble Fork Reservoir sediment release, it is recognized that sediment deposited in Tibble Fork Reservoir is likely to accrue metals from the upstream watershed, sediment from upstream is known to contain a combination of naturally-occurring and anthropogenic metals sources. The DWQ collected sediment samples upstream of Tibble Fork Reservoir during the recent dam breech/sediment release which showed detected concentrations of many metals (arsenic, barium cadmium, copper, lead, zinc, and others). However, background metals concentrations from sediment locations that are outside the influence of mining are not available to be able to determine if and to what magnitude these metals concentrations are elevated (since the metals are also naturally-occurring). Metals concentrations in sediment are likely to be variable depending on stream morphology/depositional areas, magnitude of snowmelt and associated run off during a given month or year, and other complexities associated with sediment geochemistry and sediment transport mechanisms. Baseline data which would allow for the ability to compare the natural variability/range of metals concentrations that may occur in the drainage above and below the reservoir, as well as above and below other major tributaries, is not available for this report.

5.2.7 Conclusions

5.2.7.1 North Fork American Fork - from Bog mine to MEG

Historically reported concentrations of cadmium, zinc, and iron in surface water have exceeded the Observed Release criteria (three times background concentrations) from the Lower Bog and Pacific mines; however, the three times background concentrations for all metals, except one exceedance for cadmium, have been significantly below all water quality benchmarks and standards protective of human health and the environment.

Prior to clean up activities, concentrations of cadmium and lead had exceeded WQS at locations in the North Fork American Fork immediately downstream of the mines in the upper watershed. Cadmium concentrations decreased to non-detectable levels beginning just downstream of Lower Bog mine. Lead levels persisted at concentrations exceeding WQS in North Fork American Fork from downstream of Pacific mine to just downstream of the confluence with MEG; however, concentrations were generally only slightly above chronic WQS. As result, there are likely insignificant impacts to surface water and human health or the environment from waste sources and mine sites in this reach. It should be noted that detection limits for cadmium in the 2007 sampling events were significantly higher than the WQS, thus, all non-detect results in 2007 are too high to determine if the concentrations of cadmium in the water have historically complied with the WQS. However, the detection limit for the sample collected in 2008 was below the WQS and the results were above both acute and chronic WQS, suggesting potential impacts from cadmium in this reach.

The adit drainages from the two mines in this segment continue to discharge significantly elevated cadmium and zinc concentrations into the headwaters of the North Fork American Fork River. While grab samples from representative periods of high and low flow indicate WQS were generally not exceeded, episodic surges or pulse loading from these adits have the potential to have impacted the downstream managed, harvestable fishery and wetlands.

5.2.7.2 MEG - from upper MEG tributary to above confluence with North Fork American Fork

Evaluations using EPA HRS criteria indicate that an Observed Release can be documented based on discharges of elevated dissolved arsenic, cadmium, copper, iron, and zinc from Yankee and Globe mines. Dissolved zinc and cadmium are reported at similar concentrations during the high flow versus low months, and elevated zinc concentrations in the Live Yankee Adit No. 1 continues to be observed in MEG downstream of the adit discharge above both acute and chronic Aquatic WQS. All concentrations in the gulch are below agricultural WQS. Dissolved cadmium concentrations are consistently above 4-Day Average (chronic) WQS throughout the year, beginning from the upper MEG watershed downstream to the lowest-downstream location at the mouth of MEG. The occurrence of elevated cadmium both upstream and downstream of the mine sites indicates a potential impact to aquatic life, some of which may be naturally occurring. Neither cadmium nor zinc historically exceeded Utah WQS in the North Fork of American Fork River below the MEG confluence. The available data indicate that there continues to be metals loading in MEG, which increases in a relatively isolated area of groundwater seeps below the Live Yankee Adit No. 1 and waste piles.

5.2.7.3 North Fork/American Fork River - below confluence with MEG to mouth of canyon

Results above and below MEG indicate that mining impacts in discharges from the impacted tributary do not appear to result in elevated metals concentrations in the main stem reaches of the North Fork or American Fork River. Although many sample locations have not been recently sampled (since 2000 at most locations) the historical data suggest that elevated concentrations of mining related metals have not been observed in the main stem of the American Fork River. The results at the downstream-most location (the mouth) suggest that high-quality water flows out of the American Fork River canyon and upstream of Utah Lake.

While there are some data limitations associated with the impacts from the recent Tibble Fork Reservoir sediment release, it is recognized that sediment deposited in Tibble Fork Reservoir is likely to accrue metals from the upstream watershed, as sediment from upstream is known to contain a combination of naturally-occurring and anthropogenic metals sources. The UDEQ collected sediment samples upstream of Tibble Fork Reservoir during the recent dam breech/sediment release which showed detected concentrations of many metals (arsenic, barium cadmium, copper, lead, zinc, and others). However, background sediment metals concentrations in the upper watershed are not available to be able to determine if these metals concentrations are elevated (since some of these metals are naturally-occurring).

5.3 SOIL EXPOSURE AND AIR PATHWAYS

For the targets component of this evaluation, the principal threat is related to populations that are regularly and currently present on or within 200 feet of surficial soil contamination. Nearby populations are also evaluated and include populations that are regularly present within 1-mile of observed contamination. The four populations that receive the most weight under the EPA Site Assessment process are residents, students and daycare attendees, workers, and terrestrial sensitive environments. Terrestrial sensitive environments are areas that are established or protected by State or Federal Law (examples include, but are not limited to, National Parks, threatened or endangered species habitat, wilderness areas, and wildlife refuges). The attractiveness and accessibility of the site for recreational purposes is considered in the soil pathway threat, but it is not weighted as heavily as the other non-transient uses, such as residents and workers.

The principal threat under the air pathway is the threat of airborne releases of hazardous substances. The targets evaluation is primarily concerned with identifying and evaluating the human population, as well as terrestrial and sensitive environments, within 4 miles of the site. Since no documentation of the collection of air samples or a direct observation of an air release is known to exist, no sources of gas associated with the sources have been identified, and there are not a sufficient number of residents within the four-mile radius (see Section 5.3.1.1 below), the air migration pathway was not evaluated in this PA.

Observed Contamination to soil is documented when there is an exceedance of three times the background concentration. If the background concentration is not detected, then a detection is noted in a sample if the concentration reported is greater than or equal to the background sample quantitation limit.

5.3.1 Soil Exposure and Air Pathway Targets

5.3.1.1 Resident and Worker Population

The AF Canyon consists of abandoned mines with potential source areas of waste material located in rural and remote areas of the Wasatch National Forest. There are no residents or workers within 200 feet of any potential source mine waste pile in the AF Canyon areas included in this assessment. The closest permanent resident, based on a review of Google Earth aerial imagery, appears to be 4 miles east-northeast of the waste pile at Lower Bog. According to the 2010 Census, there are no residences within ½-mile of the potential source areas (U.S. Census Bureau, 2017). All of the potential sources identified are located on private property with the exception of Lower Bog, Mary Ellen Gulch HC2, and Yankee Mine Adit #1 (Sample Location 5912280) which are located on USFS property (USFS, 2007b; American Fork Canyon Alliance, 2017). Although remote, the source areas are not fenced and do not restrict recreationists and trespassers. The source areas are bound by the MEG and American Fork canyons and ultimately by the Upper American Fork Canyon subwatershed and AF basin boundaries. The estimated population of full time residents based on 2010 census data, is listed in Table 5-2 (U.S. Census Bureau, 2017).

Table 5-2 - Population within Four-Mile Radius

Radius	Population
0 - 0.25	0
0.25 - 0.50	0
0.50 - 1.0	4
1.0 - 2.0	43
2.0 - 3.0	387
3.0 - 4.0	65

Radius	Population
Total Population	499

5.3.1.2 Terrestrial Sensitive Environments

As mentioned in Section 2.2.2.1, the ECOS and IPaC Threatened and Endangered Species databases list six different species (one bird, one fish, two flowering plants and two mammals) that may be present in the project area that are considered federal or state listed threatened, endangered, or sensitive species. The species potentially associated with the study area include the Yellow-billed cuckoo, June Sucker, Jones cycladenia, Ute ladies'-tresses, Canada lynx, and grizzly bear (USFWS, 2017a; 2017b). Of these species, only the Jones cycladenia is not known or believed to occur within the investigation area (USFWS, 2017a; 2017b). A site-specific biological survey has not been performed and therefore, data are not available to determine if these species are definitively present in the AF Canyon. In addition, none of the species listed have Designated Critical Habitat within or overlapping the investigation area or that would potentially be impacted by conditions at the mine sites.

As mentioned in Section 5.2.2.3, the Timpanogos Cave National Monument, Lone Peak and Mount Timpanogos Wildernesses are present within the lower half of the AF Canyon, and are also considered terrestrial sensitive environments. However, none of these areas are located within the ½-mile radius of a source soil used for evaluation of sensitive environments as described in Section 5.3.

5.3.2 Soil Sample Locations

Background samples were not collected as part of any previous investigations for use in the evaluation to document Observed Contamination. Because background soils data are not available, it is not known to what extent the exceedances or portions of the exceedances may be naturally occurring.

5.3.2.1 North Fork American Fork

Waste Pile Sample Locations

As discussed in Section 4.2, the USBR conducted soil, waste rock and tailings XRF screening in North Fork Canyon at the Miller Hill Tunnel and Lower Bog mine in June and October 2000. A total of 10 XRF waste rock samples were collected from nine waste rock piles for XRF analysis. Source analytical results of the maximum concentrations as reported by SAIC are summarized in Table 4b.

Soil Sample Locations

Soil XRF readings were also collected from four non-waste pile sample locations (Mill XRF52, Mill XRF54, Mill XRF34 and Mill XRF33) at the Pacific Mill and data were reviewed to document historic conditions for soils at the mine site (Trout Unlimited, 2004). Soil analytical results are summarized in Table 14.

5.3.2.2 Mary Ellen Gulch

Waste Piles Sample Locations

The EPA conducted soil/waste material sampling in MEG at the Live Yankee and Globe mines in October 2001. A total of 25 surface soil samples (including 3 duplicates) were collected from 0-4 inches bgs. Sample locations are described in Table 2 and shown on Figure 9. Soil analytical results are summarized in Table 4b.

Soil/tailings samples 2 through 86 (except samples 14, 59, 61, 64, 75, and 86) were collected from the Yankee mine tailings piles and downgradient adjacent areas in MEG in 2001 (Figure 9). Sample locations were estimated based on the figures and sample descriptions provided in the "Final Report, Yankee Mine Site, Utah County, Utah" (August 2002) (Lockheed Martin/REAC, 2002). Soil/tailings analytical results are summarized in Tables 4a and 4b.

Soil Sample Locations

Soil analytical samples were collected from five non-waste pile sample locations in MEG. Two locations (14 and 86) were located upgradient of the tailings piles at Yankee mine on the west and north sides and samples 32 and 54 (including duplicate) were collected from MEG downgradient of the Yankee mine tailings piles by EPA in August 2002 (Lockheed Martin/REAC, 2002) (Figure 9). The 2002 data are being utilized for the purposes of this PA, as they represent locations adjacent to and downgradient of the Yankee mine complex source tailing piles, and are discussed below. Soil analytical results are summarized in Table 14.

5.3.3 Soil Analytical Results Summary

Available soil/waste pile XRF screening and analytical sample results (2000-2002) from the waste piles and adjacent soils were compared to EPA Residential and Industrial RSLs in order to identify contaminants present in waste materials from each area and to determine if RSLs are exceeded (providing an initial screening benchmark and relative comparisons to gauge the potential for risks to human health and the environment if these uses were to occur).

5.3.3.1 North Fork American Fork

Waste Pile Results

As discussed in Section 4.2, lead (576 mg/kg) and silver (1,240 mg/kg) maximum XRF screening concentrations exceeded the EPA Residential RLSs of 400 mg/kg and 390 mg/kg, respectively, in the Lower Bog waste rock pile. XRF screening concentrations of arsenic (maximum concentration of 60 mg/kg) significantly exceeded both the EPA Residential (0.68 mg/kg) and Industrial (3 mg/kg) RSLs.

Soil Results

Historically, soil (non-waste pile) from Pacific Mill (Mill XRF33, 34, 52, and 54) were screened via XRF for metals concentrations. Analytical results for all of the samples indicated concentrations of lead and mercury that significantly exceeded the EPA RSLs. Arsenic also was also detected at a concentration that significantly exceeded both EPA RSLs. One sample concentration for iron (61,389 mg/kg) slightly exceeded the EPA Residential RSL (55,000 mg/kg). However, it should be noted that these samples were collected prior to clean-up activities conducted in 2002-2003 and 2006 as discussed in Section 2.3.2. The waste material from Pacific mine has subsequently been consolidated and placed in capped repositories at Dutchman Flat and Pacific mine.

5.3.3.2 Mary Ellen Gulch

Waste Pile Results

Concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, thallium, and zinc exceeded one or both EPA Soil RSLs in the samples collected from the Yankee mine tailings piles. The majority of the samples collected had concentrations of arsenic and lead that significantly exceeded both the EPA Residential and Industrial RSLs. All samples significantly exceeded both EPA RSLs by at least 14 times for arsenic.

Concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, thallium, and zinc exceeded one or more human health screening benchmark in the samples collected from the Globe mine tailings piles. At least half of the samples collected from the tailings piles had concentrations of antimony, arsenic, and iron that significantly exceeded both the EPA Residential and Industrial RSLs. All samples significantly exceeded both EPA RSLs by at least 53 times for arsenic.

Soil Results

In general, soil samples located adjacent and downgradient of the tailings piles at the Yankee mine complex indicate elevated concentrations of antimony, arsenic, cadmium, iron, lead, mercury, and zinc that exceed one or both of the EPA RSLs. All samples significantly exceeded both EPA RSLs by at least 27 times for arsenic. Lead concentrations also exceeded both EPA RSLs in all samples. Concentrations of iron (97,000 mg/kg and 93,000 mg/kg [dup]) in the most downgradient sample location (54) exceeded the EPA Residential RSL (55,000 mg/kg). The soil samples collected downgradient of the tailings pile (32) and farthest downstream of the mine site (54) had concentrations of mercury and thallium that also exceeded the EPA Residential RSL.

5.3.4 Conclusions

The results of the initial screening completed as part of this PA indicate that concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, silver, thallium, and zinc are above EPA Residential and/or Industrial RSLs in both soil and waste materials at the mine sites sampled, especially in the Yankee and Globe mine tailings. Since residential and industrial uses are not currently present in these areas, the exceedances of the RSL are not necessarily relevant, but they do provide an initial screening benchmark and relative comparisons to gauge the potential for risks to human health and the environment if these uses were to occur.

While it is beyond the scope of this PA, the EPA has developed site-specific benchmarks for other sites based on recreational exposure scenarios within similar geographic conditions as are observed at this investigation area. The EPA developed site-specific recreational exposure scenarios including those relevant to a hiker/camper and ATV rider to evaluate the potential for risks associated with these activities. While the scenarios were originally developed for the Barker-Hughesville and Carpenter-Snowcreek NPL mining sites in Montana (SRC, 2014), the American Fork Mining District and the Montana mining sites are similar in regard to sources of contamination, geography, accessibility, climate and land use. Therefore, the screening values derived for the Montana sites are presented for relative comparison to the concentrations at the American Fork mining sites.

The risk-based screening levels that were developed for the Montana sites are based on the assumption that hikers and campers will visit the site over a 16-week period (typically Memorial Day to Labor Day) and assumed a recreational user would use the site for 4-Days/week for 30 years. The ATV riders are also assumed to visit the site over a 16-week period for 3 days/week for 30 years. The assumptions related to use are purposely "conservative" (designed to estimate the highest possible exposures) in order to eliminate the possibility of underestimating risks. Using this approach, it is likely that risks are negligible if soil concentrations at the site are below the conservatively-designed screening benchmarks. The following screening benchmarks for lead and arsenic are a result of the above assumptions and are presented in Table 5-3.

Table 5-3 - Recreational Screening Benchmarks

Hiker/ Camper Screening Level		**ATV Rider Screening Level**	
Lead (ppm)	Arsenic (ppm)	Lead (ppm)	Arsenic (ppm)
20,000	4,200	8,800	480

A comparison of the recreational screening benchmarks to soil and waste material concentrations of arsenic and lead detected at each of the mine sites (Tables 4a, 4b and 14) indicates that there are exceedances for the Hiker/Camper and ATV Rider exposure scenarios. This initial comparison of individual or discrete soil sample concentrations to screening levels is considered conservative because hikers/campers/ATV Riders will use a large area that may include portions of the mine waste piles but also would include the surrounding non-impacted areas, and would not be expected to be exposed to a single point as represented by a comparison to each single sample location. The exposure scenarios and assumptions incorporate long term use and duration in order to ensure that risks are not underestimated, but also may not necessarily reflect actual uses at this investigation area.

It is also important to note that there may be other sources present within the AF Canyon that have not yet been sampled and/or are not being evaluated in this PA. The sample analytical results obtained and being evaluated for this PA do not necessarily represent all mine waste piles within the AF Canyon, as some have previously been addressed and others not evaluated.

6.0 SUMMARY AND CONCLUSIONS

The AF Canyon is primarily used for recreational activities such as motorized sightseeing, ATV and Jeep riding, fishing, exploring mine sites, picnicking, hiking, camping, hunting, equestrian riding and private uses for activities associated with the Snowbird resort. Heavy use is made of the streams and old mine sites. The potential sources evaluated in this PA are currently on property owned by Snowbird and the USFS.

Historically, releases of heavy metals to surface water have occurred from most notably the Bog, Pacific, Dutchman, Yankee and Globe mine sites all located in the upper portion of the watershed. The majority of these sources have had various cleanup activities performed except the Yankee and Globe mine tailings and the Miller Hill Tunnel waste rock piles located in MEG. During the 2017 site reconnaissance, the adit drainage from the Live Yankee Adit No.1 was observed to be partially diverted from the drainage pipe (bypassing the remediation system) with half of the discharge flowing over the tailings piles and into Mary Ellen Creek, thereby potentially increasing metals loading to MEG.

Based on the sources of known or suspected hazardous waste, historic investigation area uses, and observations and pH readings collected during the site reconnaissance activities previously described, the COPCs in the AF Canyon are heavy metals (aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, mercury, nickel, thallium, and zinc). The COPCs and their associated sources are summarized in Table 6-1.

Table 6-1 - American Fork Canyon - Potential Mining Sources

Source	COPCs	Citation	Waste Features	Citation
North Fork American Fork River				
Lower Bog Mine Adit Drainage	Cadmium, copper, iron, lead, and zinc	Lidstone & Anderson, 1993	pH of 5.1, discharge rate of approximately 44 gpm	Lidstone & Anderson, 1993
			pH of 4.86, discharge rate of approximately 40-50 gpm	Observed during August 2017 site reconnaissance
Lower Bog Mine Tailings Pile	Lead, silver, and zinc	SAIC, 2001	Approximately 69,000 cubic feet	Lidstone & Anderson, 1993
Pacific Mine Adit Drainage	Cadmium, copper, lead, and zinc	Lidstone & Anderson, 1993	pH of 5.1, discharge rate of approximately 44 gpm	Lidstone & Anderson, 1993
			pH of 7.00, discharge rate of approximately 30-40 gpm observed during August 2017 site reconnaissance.	Observed during August 2017 site reconnaissance

Source	COPCs	Citation	Waste Features	Citation
Miller Hill Tunnel HC10 Waste Rock Pile	Arsenic, lead, manganese, and zinc	SAIC, 2001	Approximately 97,000 cubic feet. Located approximately 40 ft from spring fed creek and American Fork River	Observed during August 2017 site reconnaissance
Mary Ellen Gulch				
MEG HC2 Waste Rock/Tailings Pile	Heavy metals (presumed based on mining history and area geology)	NA	Approximately 22,500 cubic feet. Located approximately 140 ft from spring fed east tributary to Mary Ellen Creek.	Observed during August 2017 site reconnaissance
Globe Mine Tailings Piles	Arsenic, copper, lead, mercury, and zinc	Lockheed Martin/REAC, 2002	Approximately 278,320 cubic feet. Located adjacent to Mary Ellen Creek.	Observed during August 2017 site reconnaissance
	Antimony, cadmium, iron, thallium, and zinc	Current PA, Table 5b		
Yankee Mine Adit #1 (MLID 5912280) Drainage	Arsenic, iron, and zinc	Current PA, Table 4b	Discharge rate between 0.3 cfs and 0.1.4 cfs	UDEQ, 2017c
Live Yankee Adit No. 1 (a.k.a Yankee Mine Adit #4) Drainage (MLID 5912310)	Aluminum, antimony, arsenic, barium, manganese, nickel	Lockheed Martin/REAC, 2002	pH of 5.95, discharge rate of approximately 70 gpm	Lidstone & Anderson, 1993
			pH of 6.72 and greater than 5 gpm	Lockheed Martin/REAC, 2002
			pH 6.27 and half of drainage observed flowing over tailings piles into Mary Ellen Creek	Observed during August 2017 site reconnaissance
	Cadmium, copper, iron, lead, and zinc	Current PA, Table 5b		
Yankee Mines Tailings Piles	Arsenic, copper, lead, mercury, and zinc	Lockheed Martin/REAC, 2002	Approximately 1,553,450 cubic feet. Located adjacent to Mary Ellen Creek.	Observed during August 2017 site reconnaissance
	Antimony, cadmium, iron, thallium, and zinc	Current PA, Table 5b		

The main routes of exposure to the contaminants present in the AF Canyon are surface water and soil/waste material. The associated targets of concern for these pathways include aquatic life, wetlands, and people recreating on and near mine sites.

Groundwater is not the primary source of drinking water within four miles of the mine sites and within the investigation area. The two springs located between two and four miles of the mine sites that are used for potable supplies to transient populations are not hydrologically connected to the potentially affected drainage. Therefore, groundwater drinking water targets are not likely to be impacted by any COPCs associated with the potential sources in the AF Canyon. This point is moderated by results from previous groundwater sampling of drinking water sources in the AF Canyon having not detected any metals above primary drinking water screening limits (UDEQ, 2017b).

The majority of the surface water data that was evaluated, with the exception of MEG, are greater than nine years old. As such, the data may or may not reflect current water quality conditions in the river. However, there is little evidence to suggest that water quality in the North Fork/American Fork River has declined in recent years due to contaminant releases from historic mine sites. Following clean-up activities along the North Fork American Fork River in the early to mid-2000s, water quality is shown to have improved downstream of the mines. Although several draining adits in the upper North Fork American Fork and MEG continue to discharge elevated concentrations of cadmium and zinc, there are not widespread exceedances of WQS in the receiving water bodies, with the exception of cadmium and zinc in MEG. In MEG, the exceedances may indicate impacts to aquatic life just downstream of the Yankee and Globe mines, but the concentrations drop below WQS near the mouth of MEG and do not appear to impact water quality in the downstream North Fork American Fork River. In the North Fork and main stem of the American Fork River the available surface water sample metals concentrations are generally below WQS indicating that there are not significant impacts to aquatic life or wetlands.

The American Fork River and tributaries are used extensively for recreation and contain high quality aquatic habitat downstream of disturbed areas, which may see future development or may otherwise be impacted by changing conditions in the watershed. Current water quality conditions in the river are not known. The collection of water quality samples, in particular on the North Fork and the main stem of the American Fork River, would be beneficial in verifying the above conclusions, but also in establishing a baseline to gauge any potential future impacts. While there have been several extensive historic sampling events, it’s important to note that the ‘grab’ water quality sampling techniques do not evaluate the potential for episodic surges (i.e., blowouts) or pulse loading from the draining adits, which could impact the downstream managed, harvestable fishery and wetlands.

Since 1991 there have been no reported exceedances of Utah WQS in the Tibble Fork Reservoir. The Utah DWQ monitors the Tibble Fork Reservoir for state designated beneficial uses of the waterbody (UOAR, 2017). The use classes are protective of recreation, aquatic life, and agricultural uses according to UAC Rule R317-2 Standards of Quality for Waters of the State (June 2017) (UOAR, 2017). This monitoring includes the collection of water for dissolved metals. According to the DWQ records, the reservoir currently meets the state criteria for these designated uses (UDEQ, 2018b).

The sediment chemistry and benchmark comparisons provide some insights into the potential for aquatic life impacts, but benthic macroinvertebrate community surveys provide a better indication of the actual invertebrate conditions in the ecosystem. While there are exceedances of available aquatic life sediment benchmarks, evaluation and interpretation of sediment toxicity based solely on analytical results with comparisons to generic benchmarks is not appropriate. The results of the macroinvertebrate survey (UDEQ, 2016) indicate that there were impacts to the benthic community in the 2-mile stream reach directly below the Tibble Fork Reservoir following the sediment release. Based on the similarity of the sediment metals concentrations in the reaches with versus without invertebrate communities (compare UDEQ upstream of the Tibble Fork Reservoir sample 4994990 with downstream sample 4994984), and the fish kill that occurred in the same reach at the same time, it is likely that impacts to the macroinvertebrate community in the 2-mile downstream reach is at least partially related to the physical smothering/clogging action hindering respiration and elimination/reduction of benthic habitat (e.g., filling in of interstitial pore space).

While the available analytical sediment results can provide some insights into metals contaminant distribution in river, baseline sediment conditions in American Fork prior to the Tibble Fork sediment release, and historical background or reference area sediment locations representing sediment conditions above and below key mining areas are not available. Co-located surface water and sediment samples strategically located above and below key disturbed areas would be needed to assess the impacts from mines in the watershed.

Surface soil and waste pile samples collected at the mine sites contain elevated concentrations of antimony, arsenic, cadmium, copper, iron, lead, mercury, silver, thallium, and zinc when compared to EPA Residential and Industrial RSL human health screening benchmarks; however, neither residential or industrial uses currently occur within the investigation area, therefore these comparisons are only provided for informational purposes. Should residential or industrial uses occur in the future, these exceedances may present a concern.

A comparison of these soil and waste pile concentrations to recreational screening levels indicates hiker/camper and ATV Riders screening benchmarks for arsenic and lead are exceeded. Based on the available data, the Yankee and Globe mine tailings piles present the greatest potential for exposure from a recreational standpoint. Both mines are accessible and attractive to people due to their location and presence of historic mining features. The potential for these recreational exposures at these locations merits further attention.

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		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Salt Lake Daily Tribune and Utah Mining Gazette, 1873	Newspaper Article	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Seager, 2017	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Skabelund, Paul H., 1989. Forester. United States Forest Service. Memorandum to District Ranger, D-2, Subject: Abandoned Mine Reclamation. May 15, 1989. 4 pages.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Skabelund, 1989	Memorandum	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Shelley, 1945	Book	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Snowbird Ski and Summer Resort (Snowbird), 2015. Snowbird Ski and Summer Resort Mary Ellen Gulch Expansion CUP Application. December 7, 2015.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Snowbird, 2015	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
SRC, 2014	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Stokes, William L., 1986. *Geology of Utah.* Salt Lake City, Utah. Utah Geological and Mineral Survey and Utah Museum of Natural History, 1986. Print.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Stokes, 1986	Book	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Sutton, 1949	Book	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Trueman, Ursula, K., 1991. Superfund Branch Manager. Utah Department of Environmental Quality, Division of Environmental Response and Remediation. Memorandum to Paul Arell, U.S. EPA Region VIII. November 22, 1991.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Trueman, 1991	Memorandum	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
U.S. Census Bureau, 2016	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

U.S. Census Bureau, 2010. American Fact Finder. 2010 Population Finder, 2010 Demographic Profile Utah County, Utah, and Highland city, Cedar Hills city, and American Fork city, Utah. American Fact Finder, www.factfinder2.census.gov. Accessed March 22, 2017.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
U.S. Census Bureau, 2010	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

U.S. Environmental Protection Agency (EPA), 2017a. Regional Screening Levels (RSL) – Generic Tables. June 2017. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2017a	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2017b	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 2016. Superfund Site Information. American Fork Canyon/Uinta National. EPA ID: UTD988074951. Accessed November 22, 2016. Available at: https://cumulis.epa.gov/supercpad/CurSites/csitinfo.cfm?id=0801228&msspp=.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2016	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2014	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2012	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2006	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2003	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2003	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 2001. Paul Damian, Program Manager, Risk Assessment and Toxicology, Tetra Tech EM Inc. (Tetra Tech). Memorandum to Pete Stevenson, EPA Region VIII On-Scene Coordinator, Subject: START2, EPA Region VIII, Contract No. 68-W-00-118, TDD No. 0101-0008. Imminent and Substantial Endangerment to Human Health and Environment Due to Metals Contamination at American Fork Canyon Sites, Uinta National Forest, Utah County, Utah. March 21, 2001. 17 pages.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 2001	Memorandum	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 1995a. Preliminary Assessment Decision – EPA Region VIII. American Fork Canyon. UTD988074951. September 12, 1995.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1995a	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 1995b. *Establishing an Observed Release.* OSWER Directive 9285.7-20FS. EPA540-F-94-031. September 1995.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1995b	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 1992a. *Guidance for Performing Site Inspections Under CERCLA, Interim Final.* OSWER. Directive 9345.1-05. EPA540-R-92-021. September 1992.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1992	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 1992b. *Hazard Ranking System Guidance Manual.* OSWER Directive 9345.1-07. EPA540-R-92-026. November 1992.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1992b	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

EPA, 1991. *Guidance for Performing Preliminary Assessments Under CERCLA*. OSWER Directive 9345.0-01A. EPA540-G-91-013. September 1991.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1991	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
EPA, 1990	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 1994	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
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USFS, 2002a. *Engineering Evaluation & Cost Analysis for American Fork Canyon Mine Reclamation Project*. Pleasant Grove Ranger District. Uinta National Forest Intermountain Region. March, 2002.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2002a	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2002b	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFS, 2003. Photo Record of AFC Removal Actions.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2003	Photo Log	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFS, 2007a. *American Fork AML Water Quality Monitoring*. Unpublished Data. No Date.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2007a	Spreadsheet	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFS, 2007b. *Environmental Assessment. Winter Motorized Use Forest Plan Amendment and Travel Management*. August, 2007.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2007b	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFS, 2008. *Decision Memo. Tibble Fork and Silver Lake Recreation Residence Tracts Special Use Permits Issuance*. Uinta-Wasatch-Cache National Forest, Pleasant Grove Ranger District. November 5, 2008.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFS, 2008	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

U.S. Fish & Wildlife Service (USFWS), 2017a. *Environmental Conservation Conversation System (ECOS)*. Accessed February 15, 2017. http://ecos.fws.gov/ecp/.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFWS, 2017a	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFWS, 2017b. *Information, Planning, and Conservation System (IPaC)*. Accessed February 15, 2017. http://ecos.fws.gov/ipac/.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFWS, 2017b	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

USFWS, 2017c. *National Wetlands Inventory, Wetlands*. Updated March, 2017. https://gis.utah.gov/data/water-data-services/wetlands/

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USFWS, 2017c	Geodatabase	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

U.S. Geological Survey (USGS), 2017. USGS Surface-Water Annual Statistics for the Nation for gauging station 10164500 American FK AB Upper Powerplant NR American FK, UT. Accessed May 26, 2017. Available at: https://waterdata.usgs.gov/nwis/annual?referred_module=sw&site_no=10164500&por_10164500_143649=449054,00060,143649,1927,2017&year_type=W&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
USGS, 2017	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah County Board of Adjustment, 2016. Report from the Zoning Administrator to the Utah County Board of Adjustment for Appeal NO. 1552. January 7, 2016.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Utah County Board of Adjustment, 2016	Application	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Department of Environmental Quality (UDEQ), 2002. Utah Lake – Jordan River Watershed Management Unit Stream Assessment. August, 2002.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2002	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2004. Utah's 2004 303(d) List of Waters. April 1, 2004.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2004	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2016a. Evaluation of UDEQ Water Quality Data following the Tibble Fork Reservoir Sediment Release. September 8, 2016. Available at: https://deq.utah.gov/locations/T/tibble-fork-reservoir/documents/Tibble-Fork-Screening-Analysis.pdf

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2016a	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2016b. Notice of Violation and Compliance Order Docket No. I16-07. September 28, 2016. Available at: https://deq.utah.gov/locations/T/tibble-fork-reservoir/documents/2016-09-27-notice-of-violation.pdf

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2016b	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2017a. Docket No. I16-07 Settlement Agreement. 2017. Available at: https://documents.deq.utah.gov/water-quality/facilities/north-utah-county-water-conservancy/tibble-fork-reservoir/DWQ-2017-002712.pdf

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2017a	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2017b. Kim Shelley. Division of Water Quality. Email correspondence with Allen, Mark. Protect & Preserve American Fork Canyon, Subject: Remediation plan for Tibble, AF River, Secondary Water Users. January 13, 2017. 6 pages.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2017b	Email	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2017c. Ambient Water Quality Monitoring System (AWQMS) Database. Emailed from Scott Daly. Utah Lake Watershed Coordinator. Division of Water Quality.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2017c	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2017d. Kevin Okleberry. Emergency Response/Spill Coordinator. Division of Water Quality. Email correspondence with Natalie Quiet. Weston Solutions, Subject: Remediation plan for Tibble, AF River, Secondary Water Users. December 8, 2017. 3 pages.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2017d	Email	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2018a. Linda Gould. Archivist. Division of Water Quality. GRAMA Request. February 13, 2018. 44 pages.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2018	Email	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UDEQ, 2018b. Utah Environmental Interactive Map. Version 1.3.3. Available at: https://enviro.deq.utah.gov/

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDEQ, 2018b	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Department of Natural Resources (UDNR), 2009. Well Information Database. Division of Water Rights. Revised September 10, 2009. Available at: http://maps.waterrights.utah.gov/EsriMap/map.asp?layersToAdd=wellsearch

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDNR, 2009	Database	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Division of Wildlife Resources (UDWR), 2017. Fishing Reports. https://wildlife.utah.gov/hotspots/. Accessed February 15, 2017.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UDWR, 2017	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah: Her Cities, Towns, and Resources, 1892. Chicago: Manly and Litteral. p. 14.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Utah: Her Cities, Towns, and Resources, 1892	Book	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Mining Gazette, 1874. “American Fork District.” Salt Lake City. March 7, 1874, P. 2.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Utah Mining Gazette, 1874	Newspaper Article	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Mining Journal, 1872. “Local Intelligence.” July 16, 1872, P. 3.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Utah Mining Journal, 1872	Newspaper Article	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Utah Natural Heritage Program (UNHP), 2015. *Utah’s State Listed Species by County*. Biodiversity Tracking and Conservation System (BIOTICS). http://dwrcdc.nr.utah.gov/ucdc/ViewReports/sscounty.pdf. Last Updated on October 1, 2015.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
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Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UOAR, 2014	Document	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UOAR, 2017a. Utah Administrative Code Rule R317-6. Ground Water Quality Protection. https://rules.utah.gov/publicat/code/r317/r317-006.htm. November 1, 2017.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UOAR, 2017a	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

UOAR, 2017b. Utah Administrative Code Rule R317-2. Standards of Quality for Waters of the State. https://rules.utah.gov/publicat/code/r317/r317-002.htm. June 1, 2017.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
UOAR, 2017b	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Western Mining Gazetteer, 1880. “Rush Valley and American Fork Districts, Utah”. Salt Lake City. September 22, 1880 p. 4.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Salt Lake Daily Tribune and Utah Mining Gazette, 1873	Newspaper Article	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Western Regional Climate Center (WRCC), 2016a. Temperature and Precipitation Data for Alta, Utah. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut0072. Accessed November 2, 2016.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
WRCC, 2016a	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Western Regional Climate Center (WRCC), 2016b. Temperature and Precipitation Data for Timpanogos Cave. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut8733. Accessed November 2, 2016.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
WRCC, 2016b	Website	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Zoning Administrator, 2016. Report from the Zoning Administrator to the Utah County Board of Adjustment for Appeal NO.1552. January 7, 2016.

Citation	Reference Type	Assessment Factor				
		Soundness	Applicability and Utility	Clarity and Completeness	Uncertainty and Variability	Evaluation and Review
Zoning Administrator, 2016	Memorandum	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

TABLES

FIGURES

APPENDIX A
American Fork Canyon TDD Preliminary Assessment Site Reconnaissance Trip Report

APPENDIX B
Summary of 1992 Mine Inventory

APPENDIX C
CERCLA Authority Checklist

APPENDIX D
Potential Hazardous Waste Site Preliminary Assessment Form

APPENDIX E
Conceptual Site Model

APPENDIX F
Ambient Water Quality Monitoring System Database Summary for American Fork